Journal of Young Scientist, Volume III, 2015
ISSN 2344 - 1283; ISSN CD-ROM 2344 - 1291; ISSN Online 2344 - 1305; ISSN-L 2344 – 1283

ASPECTS CONCERNING TOPOGRAPHIC AND GEODETIC WORKS NECESSARY FOR DESIGNING AND DRAWING A CONSTRUCTION

Dorinuţa BEŞA, Adina Mihaela MORAR, Nicoleta Alina MUREŞAN

Scientific Coordinators: Prof. PhD Eng. Mircea ORTELECAN, Lect. PhD Eng. Tudor SĂLĂGEAN

University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Calea Mănăştur 3-5, 400372, Cluj-Napoca, Romania | Tel: +40-264-596.384 | Fax: +40-264-593.792 E-mail: contact@usamvcluj.ro

Corresponding author email: besa_dorinutza@yahoo.com

Abstract

The following paper regards the creation of the digital plan necessary for the design and trace of a construction situated in the town of Colibita, in the Bistrita-Nasaud county. Further, the paper presents the methods of tracing and the study of accuracy in regards to the transposition on terrain of the projected objective. The methods used for drawing in a plan of the projected points of a construction results combining topographic mapping elements (angles and horizontal distances) and deploys according of well defined procedures. Before starting a construction, first you should realize the preparing of terrain by topographical point of view. This fact consists of an ensemble of operations made at office for making the construction at that terrain. For drawing of the projected elements, polar coordinates method has been chosen. This is the most used method of drawing, it is used for drawing on the terrain of project points in case if exists a drawing base or a drawing network, a poligonometric network, a topographic construction network.

***Key words**: angles, digital plan, poligonometric network, topographic, terrain.*

INTRODUCTION

This paper is part of the diploma project, which aims to draw and design a construction relating to a property in the area Colibita.

In order to design the objective mentioned it is necessary to create digital terrain model.

On the digital support has passed the location of the building and calculate the coordinates of points of construction.

Topo-geodetic operations have targeted achieving digital support and implementation in the field of building design.

In order to achieve the topographical plan has gone from a network of triangulation in the area of interest, then a passing to the geodetic networks and the lifting realization network.

From the lift network have been determined the coordinates of terrain detail.

After placing the lens designed on digital plan was passed in the calculation of the required elements themselves.

MATERIALS AND METHODS

Triangulation network taken into study is presented in the form of three rectangles with two diagonal (Figure 1).

In order to follow the stabilization of the axis from a planimetric and altimetric perspective, the following operations were carried out: the compensation and verification of angles, the calculation of the orientations, the calculation of the sides, and the calculation of the coordinates with respect of these supporting axis points (Ghiţău, 1975; Ortelecan et al., 1998).

The higher order geodetic axis was offset by the conditional measurement method (the variation of the coordinate points) and indirect measurement method (the variation of angles and directions) (Rădulescu, 2003; Rusu, 1978).

In order to remedy the system equations of corrections contains six equations of figure and three equations of pol.

The error equations:

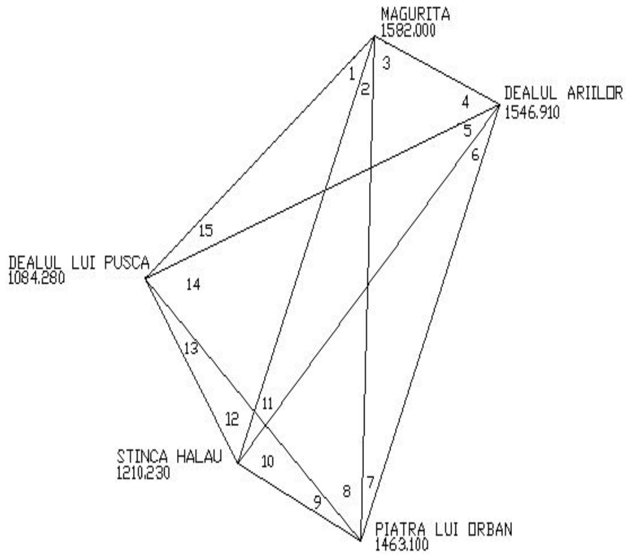

Figure 1.Sketch triangulation network

$$
\begin{cases}
v_3 + v_4 + v_5 + v_6 + v_7 + w_1 = 0 \\
v_6 + v_7 + v_8 + v_9 + v_{10} + w_2 = 0 \\
v_2 + v_8 + v_9 + v_{10} + v_{11} + w_3 = 0 \\
v_9 + v_{10} + v_{11} + v_{12} + v_{13} + w_4 = 0 \\
v_1 + v_2 + v_3 + v_4 + v_{15} + w_5 = 0 \\
v_1 + v_{12} + v_{13} + v_{14} + v_{15} + w_6 = 0 \\
d_1 v_1 - d_{15} v_{15} + d_4 v_4 - d_{2,3} v_2 - d_{2,3} v_3 + d_{11} v_{11} - d_5 v_5 + d_{13,14} v_{13} + d_{13,14} v_{14} - d_{12} v_{12} + w_7 = 0 \\
d_{4,5} v_4 + d_{4,5} v_5 - d_3 v_3 + d_7 v_7 - d_6 v_6 + d_{10} v_{10} - d_{8,9} v_8 - d_{8,9} v_9 + d_2 v_2 - d_{11} v_{11} + w_8 = 0 \\
d_4 v_4 - d_3 v_3 + d_7 v_7 - d_{5,6} v_5 - d_{5,6} v_6 + d_{14} v_{14} - d_8 v_8 + d_{1,5} v_1 + d_{1,2} v_2 - d_{13} v_{13} + w_9 = 0
\end{cases}
$$

$$
B = \begin{pmatrix} a_1 & b_1 \dots & i_1 \\ \vdots & \vdots & \vdots \\ a_{15} & b_{15} \dots & i_{15} \end{pmatrix}; B^T = \begin{pmatrix} a_1 & a_2 \dots & a_{15} \\ \vdots & \vdots & \vdots \\ i_1 & i_2 \cdots & i_{15} \end{pmatrix}; w = -\begin{pmatrix} w_1 \\ w_2 \\ \dots \\ w_9 \end{pmatrix}; v = \begin{pmatrix} v_1 \\ v_2 \\ \dots \\ v_{15} \end{pmatrix}
$$

$$
A = \begin{pmatrix} a_1 & b_1 \\ a_2 & b_2 \\ \dots\dots\dots \\ a_{16} & b_{16} \end{pmatrix}; A^T = \begin{pmatrix} a_1 \dots\dots & a_{16} \\ b_1 \dots\dots & b_{16} \end{pmatrix}; l = -\begin{pmatrix} l_1 \\ l_2 \\ \dots \\ l_{16} \end{pmatrix}; v = \begin{pmatrix} v_1 \\ v_2 \\ \dots \\ v_{16} \end{pmatrix}; P = \begin{pmatrix} 1 & 0 & \dots & 0 \\ 0 & -1 & \ddots & \vdots \\ 0 \dots & & 0 & -1 \end{pmatrix}; X = \begin{pmatrix} d_{XP} \\ d_{YP} \end{pmatrix}
$$

The error equations system can be written as a matrix, as follows:

$$B^T v = w$$

Where, B – the coefficients matrix
v - the corrections matrix
w – the unclosing matrix
Putting the minimum condition, result:

$$v^T v - 2k^T \left(Bv - w\right) \rightarrow \min$$

Is calculated:

$$k = \left(B^T B\right)^{-1} w$$

$$v = B\left(B^T B\right)^{-1} w$$

Corrections are calculated using the most probable value of the angles.

$(\hat{1}) = \hat{1} + v_1$

$(\hat{2}) = \hat{2} + v_2$

……………

$(1\hat{5}) = 1\hat{5} + v_{15}$

The standard deviation or mean square error of measurements in the case of a single conditionaed measurement is calculated and is given by :

$$S_0 = \pm\sqrt{\frac{[vv]}{r}},$$

Where, r is the number of geometric condition.
To develop the network of support was switched to thickening of network.
Writing equations of correction system. Initially supposed to write a system of twenty equations with seven strangers: Δx_P, Δy_P, $\Delta z_A, \Delta z_B, \Delta z_C, \Delta z_D, \Delta z_E$.
In order to simplify the equations apply rules 1 and 3 of equivalence of Scheiber, becoming the system in the form of:

$$a_2\Delta x_P + b_2\Delta y_P + l_2 = v_2$$

$$\frac{a_2}{\sqrt{3}}\Delta x_P + \frac{b_2}{\sqrt{3}}\Delta y_P = v_2'$$

$$a_5\Delta x_P + b_5\Delta y_P + l_5 = v_5$$

$$\frac{a_5}{\sqrt{3}}\Delta x_P + \frac{b_5}{\sqrt{3}}\Delta y_P = v_5'$$

$$a_8\Delta x_P + b_8\Delta y_P + l_8 = v_8$$

$$\frac{a_8}{\sqrt{3}}\Delta x_P + \frac{b_8}{\sqrt{3}}\Delta y_P = v_8'$$

$$a_{11}\Delta x_P + b_{11}\Delta y_P + l_{11} = v_{11}$$

$$\frac{a_{11}}{\sqrt{3}}\Delta x_P + \frac{b_{11}}{\sqrt{3}}\Delta y_P = v_{11}'$$

$$a_{14}\Delta x_P + b_{14}\Delta y_P + l_{14} = v_{14}$$

$$\frac{a_{14}}{\sqrt{3}}\Delta x_P + \frac{b_{14}}{\sqrt{3}}\Delta y_P = v_{14}'$$

$$-a_{16}\Delta x_P - b_{16}\Delta y_P + l_{16} = v_{16}$$

$$-a_{17}\Delta x_P - b_{17}\Delta y_P + l_{17} = v_{17}$$

$$-a_{18}\Delta x_P - b_{18}\Delta y_P + l_{18} = v_{18}$$

$$-a_{19}\Delta x_P - b_{19}\Delta y_P + l_{19} = v_{19}$$

$$-a_{20}\Delta x_P - b_{20}\Delta y_P + l_{20} = v_{20}$$

$$\frac{-[a\ ]}{\sqrt{5}}\Delta x_P + \frac{-[b]}{\sqrt{5}}\Delta y_P = v'$$

We get a system of sixteen equations with two unknowns.
The system of equations can be written in the form of matrix, as follows:

$$AX + l = V$$

Where, A – the coefficients matrix
X – the unknowns matrix
l – the free terms matrix
V – the corrections of measured matrix

Putting the minimum condition $V^T pV \rightarrow \min$, we get the unknowns matrix which takes the form:

$$X = (A^T pA)^{-1}\ A^T pl$$

The standard deviation or mean square error of measurements in the case of a single conditionaed measurement is calculated and is given by :

$$S_0 = \pm\sqrt{\frac{V^T pV}{n-k}},$$

Where, n – the number of initial equations
r – the number of initial unknowns

To realize the lift network has created a traverse in closed circuit and were determined the coordinates of station with the following formulas:

$$X_i' = X_{i-1} + d_{i-1,i} * \cos\theta_{i-1,i}$$

$$Y_i' = Y_{i-1} + d_{i-1,i} * \sin\theta_{i-1,i}$$

Where, i=P,1,2,...7
Coordinates are the errors:

$$W_X = X_i - X_i^{'}$$

$$W_Y = Y_i - Y_i^{'}$$

$$W_{X,Y} = \sqrt{W_X{}^2 + W_Y{}^2}$$

Tolerance:

$$T = 0.003\sqrt{[D]} + \frac{[D]}{5000}$$

Orientations are errors:

$$W_\theta = \theta_{P1} - \theta_{P1}^{'}$$

$$T_\theta = 20^{cc}\sqrt{n}$$

$$C_{\theta^o} = \frac{W_\theta}{n}$$

RESULTS AND DISCUSSIONS

As mentioned at the beginning, in order to design the building was realize the topographical plan which contain the level curves of the land (Figure 2 and 3).

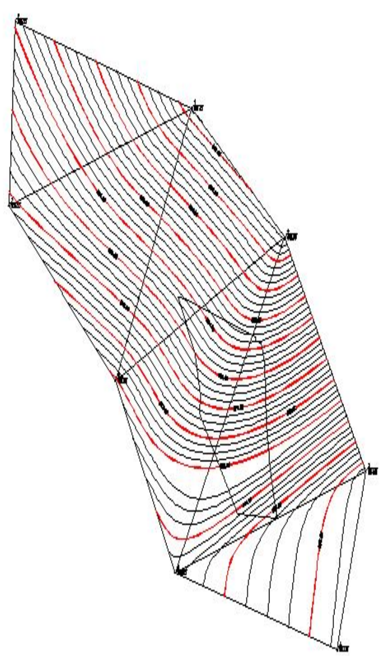

Figure 2. Polar coordinates method

Taking into consideration that all the details of the construction are determined by their axes, the tracing of the construction will consist of the following: drawing axes from the network and trace in detail towards the axes materialized on the ground (Coşarcă, 2011; Cristescu, 1978).

The design and implementation will take into account the basic axes and intermediate axes (Pop and Ortelecan, 2005). The basic axes are the axes that form the external contour of the construction (Figure 4).

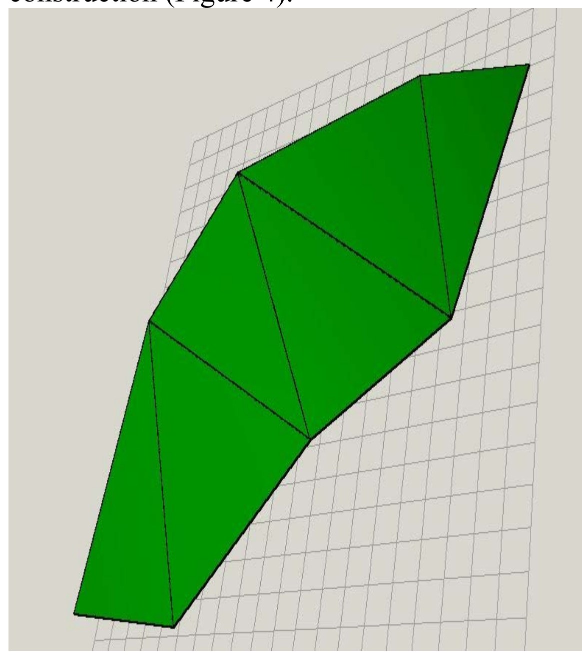

Figure 3. 3D model of the terrain

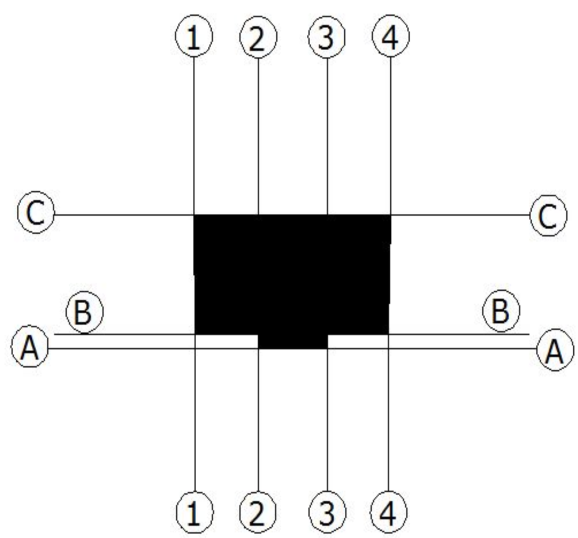

Figure 4. The basic axes of a construction

Trace the plan of the building is done by the method of polar coordinates (Figure 5).

For the trace of characteristic points of construction, during the preparation of topographical, are calculate the polar tracking items (β and d6-1c).

Coordinates of 6 and orientation θ_{6-1c} are known from the composition of trace, and 1 c, the coordinates are taken from the topographical plan.

$$\beta = 400 - (\theta_{6-7} - \theta_{6-1c})$$

$$d_{6-1c} = \frac{X_{1c} - X_6}{\cos\theta_{6-1c}} = \frac{Y_{1c} - Y_6}{\sin\theta_{6-1c}} = \sqrt{\Delta x^2 + \Delta y^2}$$

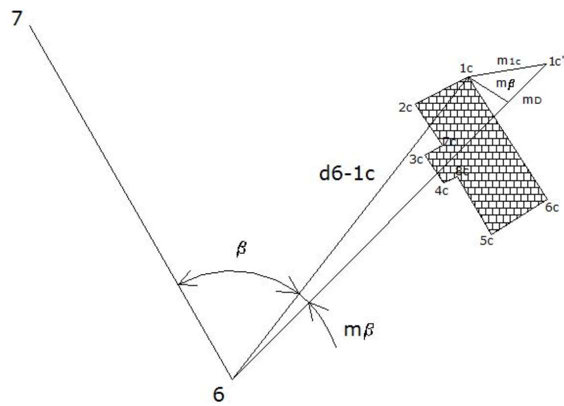

Figure 5. Polar coordinates method

Polar method is reduced to trace on the ground the steering angles β and the polar distances.

The average position error of the point drawn is calculated using the relationship:

$$m_{1c} = \pm\sqrt{m_D{}^2 + D^2\frac{(m_\beta)^2}{(\varphi^{cc})^2} + m_f{}^2}$$

Where,

mD – the error trace distance

mβ – the error trace angle

mf – the fixing error of the point 1c on the ground

The precision of the tracing of the horizontal angles: The precision of the tracing of angle β from the project depends on the centering error of the stationary point (me), the centering error of the covered mark or the error of reduction (mr), the

actual errors of measurement (mm), the instrumental errors (mi), and of the influence of external conditions (mCE).The average tracing error of quadratic field directions on the ground, with the help of theodolite is given by:

$$m_d = \pm\sqrt{m_e{}^2 + m_r{}^2 + m_i{}^2 + m_m{}^2 + m_{CE}{}^2}$$

Applying the principle of the equal influence of error components, as such:

$$\pm m_e = \pm m_r = \pm m_i = \pm m_m = \pm m_{CE} = \pm m$$

The comparison from above becomes:

$$m_d = \pm m\sqrt{5}$$

Conforming to the error theory and the method of least squares, the error mean square trace angle α is given by:

$$m_\beta = m_d\sqrt{2}$$

However,

$$m_d = \pm m\sqrt{5}$$

From which, the result is:

$$m_\beta = \pm m\sqrt{10}$$

The above relationship is determined, in a roughly the value of each factor first component which will allow choosing or checking the measuring process and the characteristics of the theodolite that will be used to trace:

$$m = \pm\frac{m_\beta}{\sqrt{10}}$$

Calculation of the necessary accuracy of tracking, on the ground,angles from project , start from allowed tolerance to trace a direction.

It is necessary through the project 1cm tolerance.

$$T = 1cm$$

$$T = (2 \div 3)m_\beta \rightarrow m_\beta = \frac{T}{2} \div \frac{T}{3}$$

Table 1. Calculation of the trace elements

	β	d
β1	142,8622	90,574
β2	146,9495	76,393
β3	154,3198	78,589
β7	153,5978	80,247
β4	61,0042	81,640
β5	67,6282	78,218
β6	73,2738	91,358
β8	61,8845	83,148

CONCLUSIONS

The precision offered by total station Leica TCR 705 with which we executed all the operations of land within this work fully satisfy the need for accuracy by the beneficiary of the work required both in terms of the accuracy and precision of the angles as well as trace precision from project.

ACKNOWLEDGEMENTS

This research work was carried out with the support of University of Agricultural Sciences and Veterinary Medicine of Cluj-Napoca, Department of Terrestrial Measurement and Exacts Sciences.

REFERENCES

Cosarca, C., Engineering surveying, 2011;

Cristescu, N., Engineering surveying, Didactic and pedagogic Publishing House, Bucharest, 1978.

Ghitau, D., Geodesy and gravimetry, Didactic and pedagogic Publishing House, Bucharest, 1975.

Ortelecan, M., Palamariu, M., Bendea, H., Problems in plotting the mining works, University of Petrosani Lithography, 1998.

Pop, N., Ortelecan, M., Engineering surveying, AcademicPres Publishing House, Cluj-Napoca, 2005.

Radulescu, Gh., Engineering surveying, Risoprint Publishing House, Cluj-Napoca, 2003.

Rusu, A., Surveying with elements of Geodesy and photogrammetry, didactic and pedagogic Publishing House, Bucharest, 1978.