TOPOGRAPHIC SURVEY CARRIED OUT FOR THE REHABILITATION AND MODERNIZATION OF THE ROAD FROM THE AGRO-BALNEOTURISTIC LOCATION BALA, MEHEDINŢI COUNTY

CĂLINA A., CĂLINA JENICA*, MILUȚ M., CROITORU A., IONICĂ C.E., VANGU M.
*Author to whom all correspondence should be addressed: e-mail: jeni_calina@yahoo.com

Keywords: topographic survey, GPS, total station, coordinates, topographic plan

ABSTRACT

The purpose of the work is to produce the technical documentation necessary to prepare the design and execution of all the construction works, which will be executed for the modernization and rehabilitation of the road taken in the study. In this sense, the work team carried out a preliminary topographic study based on which an overview of the situation existing on the field was formed, which also offered the possibility of the designer choosing the most suitable design and execution solutions. Topo-geodesic works were performed using the combined GPS-total station method, using modern equipment that ensured high accuracy and high economic efficiency. The final documentation obtained is of the highest technical and scientific level, respecting all the norms and requirements of precision and quality imposed by the regulations and laws in force, such engineering works, these being verified and approved by OCPI-Mehedinti.

INTRODUCTION

At the request of the beneficiary, the specialist surveyor made topo-cadastral surveys necessary for the modernization of the road in Bala, Mehedinți County. The modernization of the road from the locality of Bala was absolutely necessary, because it was in a very advanced state of degradation and no longer technically corresponded, both for the conduct of the current traffic and for the taking over of the tourist circulation that took place towards a balneoclimatic resort (Franzutti, R., Vîntu, C.R., et al, 2019). The locality being a tourist village that also has a resort must have modern and easy traffic conditions (Dobra, C. and Csosz, C., 2019), which will lead to the sustained development of agrotourism and spa tourism in the area (Iancu, T., et al, 2017), and the traffic on the road route must be carried out under maximum safety conditions. In order to carry out the work, it was necessary to carry out planimetric and levelling survey on the route of the entire road from the territory of Bala in Mehedinți county, based on which the plan of location and delimitation with quotas will be drawn up, necessary for the design, mapping and execution of the rehabilitation and modernization works (Calina, A. and Calina, J., 2019). All topographic measurements were made in the Stereographic Projection System 1970 and in the Black Sea Dimension System 1975, with the help of two South S82-V GNSS receivers and with the TC 805 total station with an accuracy of ± 5cc, under all conditions of precision and legislation, imposed on such engineering works.

WORKING METHOD

From the technical point of view, the survey was done largely with the help of GPS technology, the differential measurement method (DGPS) being used. This method is characterized by stationing a fixed receiver in a reference station, which takes data from the national network ROMPOS and the second mobile receiver (rover), which takes data from the fixed receiver. The central area of the town was raised with the help of the total station due to the height of the buildings and the low GPS signal. Four high-precision points were determined with the help of GPS, following which this network will be thickened by a supported planimetric route. With this, the dimensions of the points were determined by trigonometric leveling. Solving the supported route allowed the construction of a lifting support network on the basis of which the polar coordinates method could be used to raised all the detail and characteristic points of the route followed, using the combined surveiyng technology of the GPS-total station type.

RESULTS AND DISCUSSIONS

The building that is the object of this Technical Reception is "Modernization of the road from Bala, Mehedinți county", the road having the surface of 6784 m^2, and the work as a whole having the surface of 23485 m^2. Equipment used: two South S82-V receivers, channel number: 220, signals: GPS, GLONASS, Accuracy: static, horizontal accuracy = 3mm 1ppm (RMS), vertical accuracy = 5mm 1ppm (RMS), RTK mode , Horizontal Positioning Accuracy = 1cm, 1ppm (RMS), Vertical Positioning Accuracy = 2cm, 1ppm (RMS), Leica TC 805 Total Station, Accuracy: ± 5cc (Călina, J., et al, 2018). The field operations due to the conformation of the field were carried out as follows: first a point located at a higher level was identified, namely point 1, which was marked and then the receiver was fixed, which will remain fixed for the duration of the measurements. This point is chosen so as to ensure the signal for the entire duration of the measurements and on the entire surface to be raised. The lifting of the area was carried out with the mobile receiver, which takes data from the fixed receiver, by the method of differential measurements (DGPS), being determined the points from 2 to 1126. The minimum number of satellites used by the device during the measurements was of 11, of the type GPS and GLONASS, resulting in a very high accuracy in determining the coordinates of the points. Due to the low signal and the height of the buildings in the central area, four high precision points were determined, with the help of the mobile receiver, after which, with the help of the total station, a planimetric supported at the ends was made, to determine the skeleton of the surveiyng network, after which the points of detail required for the documentation was determined by the polar coordinates method (table1).

Table 1

Data from the field book

Point no.	Absolute rectangular coordinates		Z	Codes
	X	Y		
1	379915,868	328432,455	288,525	
2	380104,848	328319,550	265,072	grd
3	380103,892	328318,311	265,168	dr
...	...	...	...	...
1126	378925,174	328531,423	240,656	grd

When designing the support network, a very precise method was used, namely the planimetric traverse supported at the point of departure and arrival, a method that allows us to verify the data both on the ground and at the office (Calinovici I., and Călina Jenica, 2008). The traverse comprises 7 stations consisting of points: 2000, 2001, 2002, 2003, 2004, 2005 and 2006, these were marked on iron picket train and for each point the sketch was drawn up and a topographic description, including the number of the point , coordinates and data on the type of materialization. The traverse works were carried out in this way, initially the device was installed in point 2001, where it was fitted and centered on the topographic point. From this point was targeted point 2000, direction whose orientation I calculated it from coordinates, then went visa to point 2002, being measured orientation angle Θ_1 and horizontal distance $Do_{2001-2002}$, as well as vertical angle Z1. The same was done at each point, measuring the orientation angles Θ_2, Θ_3, Θ_4, Θ_5, the zenith angles Z_2, Z_3, Z_4, Z_5 and the distances between the points of traverse (figure 1).

All the data from the field were entered in table 2, based on them calculating the relative and absolute coordinates of the support points. The obtained results were verified very accurately using known procedures, and only after their rigorous verification could they be used in other elevations on the respective surface or in other works of cadastral character.

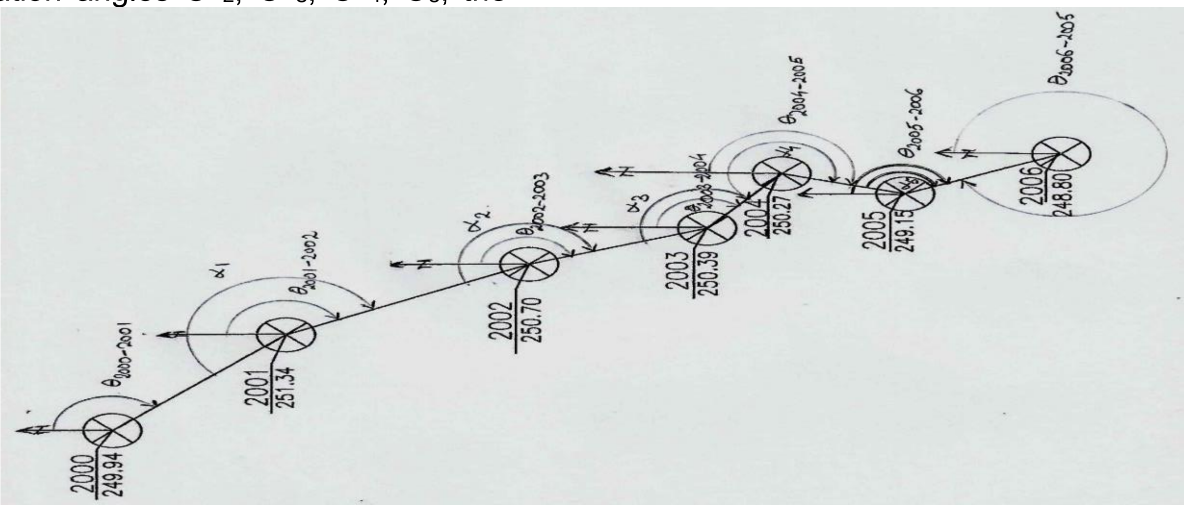

Figure 1. Outline of the support network

Table 2

Support network points calculation

Station	Target point	Horizontal distance	Orientation (θ) cos θ sin θ	+Δx	-Δx	+Δy	-Δy	Absolute rectangular coordinates X	Absolute rectangular coordinates Y	Point no.	ΔZ	Z
								379513.788	328377.819	2000	-	249.94
2000	2001	57.554	151.6208 0.724878 0.688877		41.719 +0.012 41.707	39.647 -0.006 39.641		379472.081	328417.460	2001	1.400	251.34
2001	2002	65.425	170.4633 0.894286 0.447494		58.508 +0.013 58.495	29.277 -0.006 29.271		379413.586	328446.731	2002	0.640	250.70
2002	2003	45.395	178.5761 0.943907 0.330209		42.848 +0.013 42.835	14.989 -0.006 14.983		379370.751	328461.714	2003	0.310	250.39
2003	2004	28.896	142.7029 0.621593 0.783339		17.961 +0.012 17.949	22.635 -0.006 22.629		379352.802	328484.343	2004	0.120	250.27
2004	2005	30.843	217.2105 0.963679 0.267060		29.722 +0.012 29.710		8.236 -.005 8.241	379323.092	328476.102	2005	1.120	249.15
2005	2006	41.068	173.4369 0.914205 0.405249		37.544 +0.012 37.532	16.642 -0.006 16.636		379285.560	328492.738	2006	0.35	248.80

Calculation of non-closing errors: The error on Δx; e Δx = -0.074 m; c Δx = +0.074 m; c Δx = +0.0124 Δx and +0.0132 Δx

The error on ΔY; e ΔY= 0.035 m; c ΔY= -0.035 m; c ΔY= -0.0065 ; ΔY and -0,0051 ΔY.

Total error $e_t = \sqrt{e_x^2 + e_y^2} = 0{,}081859\,\text{m}$

Tolerance calculation:

$$T = \pm(0{,}003\sqrt{\sum D} + \frac{\sum D}{5000})$$

$$T = \pm(0{,}003\sqrt{269.181} + \frac{269.681}{5000}) = 0.103m$$

The lifting of the details was carried out by polar coordinates method, defining the position of a point according to the angle and the polar distance (Sui D., 2014). This is the most widely used method by topographic specialists, applicable in any field conditions. Measurement of the angles was done in both positions of the rear window, thus obtaining a greater accuracy of measurement.

The detail points, 319 in number, were determined from several stations, these being: 2001, 2002, 2003, 2004 and 2005. The coordinates were obtained using the Toposys program, (Braun, J., Kremen, T. and Pruska , J., 2018), following the import of the measurements and then by the export, the coordinate inventory was obtained according to table 3, in the facsimile, due to the large number of data that should have been put into the paper.

Table 3

Inventory of coordinates

Point no.	X	Y	Z
3000	379481.928	328393.724	251.233
3001	379476.735	328395.217	250.400
3002	379477.980	328396.987	250.930
. . .	. . .	. . .	. . .
3344	379319.998	328465.534	249.290

Being a work of repair and modernization of a road, it was absolutely necessary to produce longitudinal profiles at all the characteristic points as well as at the points where the beneficiary requested this (Alipour, H. et al. 2019). The longitudinal profiles were performed on the 1: 2000 scales for the lengths (figure 3) and 1: 500 for the heights, at the points marked on the road axis, to represent the relief as accurately as possible. Based on the profiles prepared (figure 3) it was found that the road has slopes between 0 -16%. In adverse weather, it becomes quite difficult to practice. The road has areas with long alignments and areas with succession of curves and short alignments. The route projected in the plan is totally superimposed on the route of the existing road. For a good knowledge of the constructive elements of the roadway and an accurate representation of the situation on the ground, it was necessary to prepare the cross-sections (Raza, H., et al, 2017), at 1: 100 stairs for lengths and 1:50 for heights, being placed perpendicular to the road axis. These were executed at varying distances, due to the terrain configuration.

In the cross-sectional profiles all the important points of the road route are shown: property limits, protection zone, approach, sidewalk, road edge, road axis and other elements encountered in the field (Şmuleac, A., Popescu, C., et al, 2017).

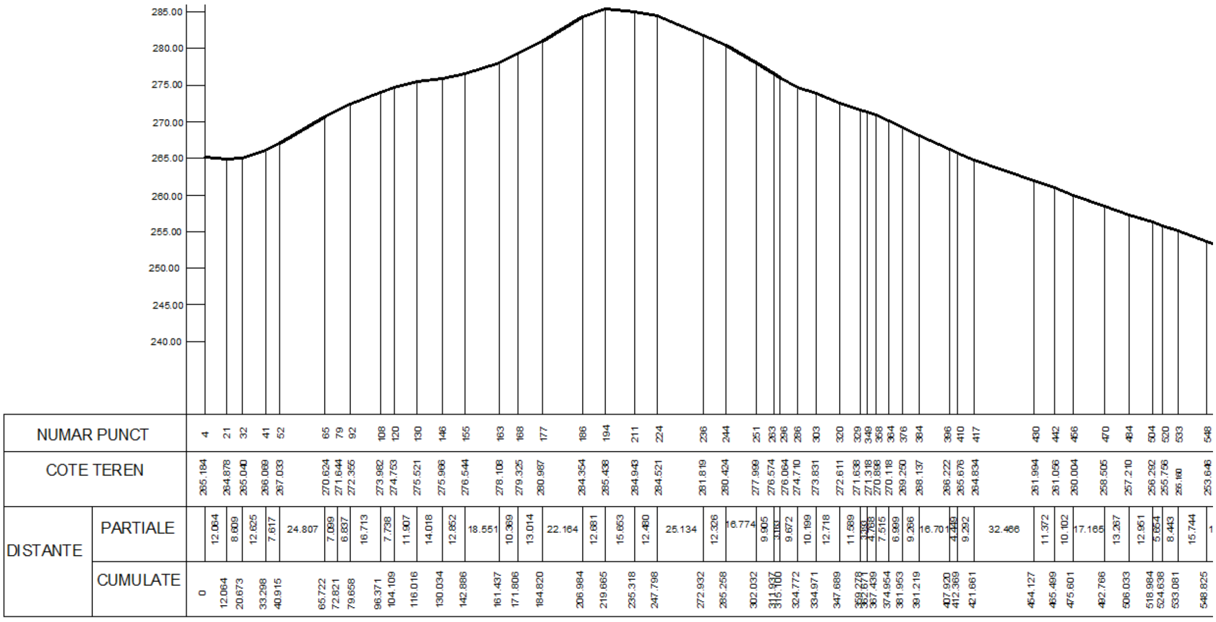

Figure 3 The components of the road shown by longitudinal profiles

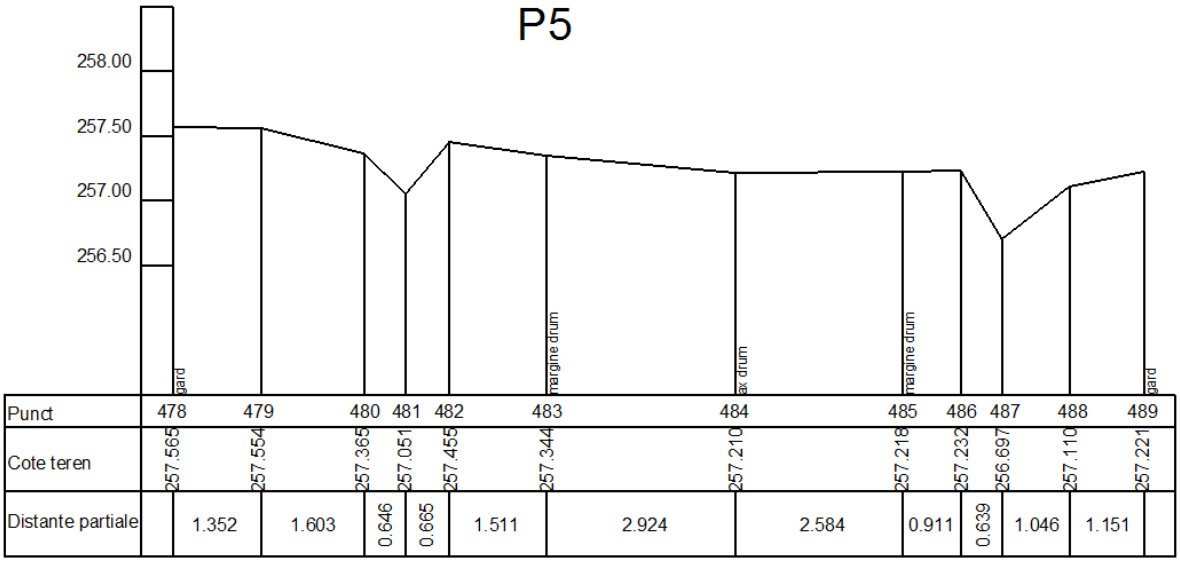

Figure 4 The components of the road shown by cross profiles

Carlson SurvCE software was used to facilitate the calculation operations and to reduce working time (Calinovici, I., 2009), based on which measurements were made directly in the national projection system Stereo 1970, SurvCE, having implemented and the program TransDat 4.01, giving the user identical results with it, in real time. This program runs on the Odin model field notebook, providing all the data related to the measurement, from the device field notebook, the txt data and files, are transferred to the computer where the location and delimitation plan is drawn up. Based on this, the design and execution of all the repair and modernization works were carried out.

CONCLUSIONS

The surveiyng methods used were very well adapted to the existing situation on the ground, which facilitated the topo-cadastral works in the best conditions and in compliance with all the technical and legal norms imposed by the legislation in force and by the beneficiary of the work. Also, the equipment used was very modern like GPS and Total Stations, the last generation, which allowed to obtain very precise data on the ground and the substantial increase of the efficiency and the efficiency of the topographic works carried out for this purpose. The data processing programs used were efficient and perfectly adapted to the topographic works carried out, which allowed the calculation of the absolute coordinates of the points and their compensation, with the highest precision required by such engineering works, while also facilitating the preparation of the site plan and precise and rapid delimitation, at the stairs requested by the beneficiary, in the different phases of the project execution project. From the ones presented above it can be seen that the working team has been permanently concerned with obtaining valuable and high precision cadastral data, which will lead to obtaining an execution project realized to the highest quality standard and which corresponds to scientific point of view at a very high level, an aspect that will lead to the accomplishment of the modernization works in the best conditions and of a faultless quality.

BIBLIOGRAPHY

1. **Alipour, H., Jalalian, A., Honarjoo, N., Tommanian, N. and Sarmadian, F.**, 2019, *Spatial and Temporal Distribution of Dust‐Bound Trace Metal Elements Around Kuhdasht Watershed Area in Iran*. *CLEAN–Soil, Air, Water*, p.1900318.

2. **Braun, J., Kremen, T. and Pruska, J.**, 2018, June. *Micronetwork for Shift Determinations of the New Type Point Stabilization.* In *2018 Baltic Geodetic Congress (BGC Geomatics)* (pp. 265-269). IEEE.

3. **Călina, J., Călina, A., Bădescu, G., Vangu, G.M. and Ionică, C.E.**, 2018. *Research on the use of aerial scanning for completing a GIS database*. *AgroLife Scientific Journal*, *7*(1), pp.25-32.

4. **Calina, A. and Calina, J.**, 2019. *Research regardig the agriproductive properties of the typical reddish preluvosol between Jiu and Olt rivers and its evolution from 1997-2017 in farms and agritouristic households.* Romanian agricultural research, *36*, pp.251-261.

5. **Calinovici I., and Călina Jenica**, 2008, *Topography*, Ed., Mirton, Timișoara.

6. **Calinovici, I.,** 2009, *Researches Concerning the Topography of an Area of Ground with the Purpose of its Agroecological Reconstruction.* In Proceedings. 43rd Croatian and 3rd International Symposium on Agriculture. Opatija. Croatia (Vol. 125, p. 128).

7. **Dobra, C. and Csosz, C.**, 2019. *Rural tourism in Romania. Characteristics and measures for future development*. Lucrări Științifice Management Agricol, 20(3), p.122.

8. **Franzutti, R., Vîntu, C.R., Smedescu, D., Ungureanu, D., Tudor, V.C. and Fîntîneru, G.,** 2019. *The national rural development program-a chance for agrotourism development in the Suceava county.* Scientific Papers: Management, Economic Engineering in Agriculture & Rural Development, 19(2).

9. **Iancu, T., Brad, I., Adamov, T., Stanciu, S., Pîrvulescu, L. and Gabriela, P.,** 2017. *Characterization of rural tourism activity in the mountain area.* Lucrări Științifice, Universitatea de Științe Agricole Și Medicină Veterinară a Banatului, Timisoara, Seria I, Management Agricol, 19(1), pp.145-148.

10. **Raza, H., Park, S.I., Lee, S.S., Tanoli, W.A. and Seo, J.**, 2017. *3D Earthwork BIM Design Process for a Road Project.* Journal of KIBIM, 7(2), pp.8-15.

11. **Şmuleac, A., Popescu, C., Bărliba, L., Ciolac, V., & Herbei, M.**, 2017. *Using the GNSS technology tothicken geodesic network in Secaș, Timiș county, Romania*. Research Journal of Agricultural Science, 49(3).

12. **Sui D.,** 2014. *Opportunities and Impediments for Open GIS. Transactions* in GIS, 18 (1), p. 1-24, doi:10.1111/tgis.12075.