Scientific Bulletin of Politehnica University Timişoara
Transactions on HYDROTEHNICS

Volume 68(82), Issue 1, 2023

TOPOGRAPHIC WORKS REGARDING THE SUSTAINABLE DEVELOPMENT OF URBAN TRANSPORT OF RESIŢA MUNICIPALITY ON ECOLOGICAL BASIS

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Abstract – Since 2015, a large-scale project was started in terms of both urban and economic development, which continues today. The municipality of Reșita was in dire need of a change to provide a more sustainable and better future. This work is based only on a section of urban development that includes the modernization of electric public transport and the development of the ecological transport infrastructure of the Municipality of Reșita.

The purpose of the topographical survey was to collect data from the field in order to modernize the electric public transport and set up the ecological transport infrastructure in the Municipality of Resita.

From the route created for the electric transport infrastructure, the paper presents the first section that includes the portion of the traffic roundabout that connects with the Intim passage. The passage crosses the railway and connects Resita Sud and Resita Nord.

Keywords: topographic survey, building infrastructure, situation plan

1. INTRODUCTION

The purpose of the paper is to present a part of the topographic study, of a model for drawing up and carrying out a work both in order to carry out topographical surveys and layouts for the implementation of a large-scale project, for the modernization of public electric transport and the development of the infrastructure of non-motorized transport in the Municipality of Reșita.

The length of the total route that is the subject of this work is 8.5 km, and includes the following streets: Republicii Boulevard, Calea Caransebesului, Calea Timisoarei, Revolutia din Decembrie Boulevard, Ion Luca Caragiale Street, Libertatii Street, Traian Lalescu, Street, Paul Iorgovici Street and Republic Square [5].

In order to carry out such a work, topographic surveys were carried out with the aim of collecting data from the field in order to modernize electric public transport and set up the non-motorized transport infrastructure.

It was not enough to carry out only the topographic survey, a topographic stake out was also carried out in order to complete the work but also to respect the designed shape and dimensions.

Being an old steel town, the population did not see a potential in it nor was it interested in its development, all this until now when the possibility of making a change was found that will lead to major changes.

This paper is based only on a part of the urban development that contains the section for the modernization of electric public transport and the development of the non-motorized transport infrastructure of Resita Municipality.

The purpose of the project is to present the steps taken to build and lay out the tram track for the project that provides for the modernization of electric public transport and the development of non-motorized transport infrastructure in the Municipality of Reșita.

The public transport in Reșita consists of 6 bus lines and a tram line and was operated by Prescom (currently non-functional). It is currently operated by Transport Urban Reșita (TUR).

Since 2008, all trams have been decommissioned and replaced by modern buses that meet EU standards (Figure 1).

Figure 1. The old situation of the tram track

(https://www.google.com/search?q=tramvai+resita+vechi&tbm)

The 2 tram lines were the Renk Muncitoresc line (1) and the Renk-Stavila line (1b), which was practically an extension of the Renk-Muncitoresc line, with only 3 trams on this line. The complete tram fleet consisted of approximately 28 trams. The last trams were the GT8 and N models imported from Germany (Dortmund and Frankfurt) and fully replaced the former Timiș trams 2 pre-89 in 2002.

In 2017, a new company was established to deal with the issue of public transport, called Transport

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Urban Reșța (TUR) with an endowment consisting of a fleet of buses and trams of modern standards for passengers, bringing a new and efficient transport system back to Resita. The fleet wants to be modernized on an ecological basis, focusing on the modernization of public electric car transport and the redevelopment of the transport infrastructure necessary for electric trams.

At the moment, the rail is built and calibrated in proportion to 90% in the Intim area (Figure 2).

Figure 2. The current situation of the tramway, the Intim bridge area

2. MATERIAL AND METHOD

From the analysis of the volume of work required for the route of the tram line, it was concluded that, in order to carry out an effective topographic survey, with the precision required by the project, two work methods are necessary, namely: GPS methods and for the survey of planimetric and altimetric details the use of the total station [1].

Since we are talking about the railway, topographic surveys must have a certain precision. Therefore, in carrying out the surveys, the Trimble S7 total station was used by the method of travel supported at the ends and erasures for planimetry and relief details.

A Trimble R8s GNSS system was used together with a Trimble TSC5 controller to determine the support points needed to carry out the supported traverse at the ends (Figure 3.) [2],[3].

Using the static method, the coordinates of the support points were determined with high precision in the Stereo 1970 coordinate system formed on the secant plane to the Krasovsky 1940 ellipsoid [4].

After analyzing the work route, it was concluded that, in order to carry out a correct survey, two work methods are necessary, namely:

a) Measurement using GPS

b) Topographical survey with the total station

Establishing work methods with the help of GPS

Positioning with the help of GPS technology was achieved by determining the parameters of the station point from at least 4 visible GPS satellites.

Figure 3. Trimble R8s receiver

The static method used the signals received from the satellites and triangulated the position in the field, following which the file created after the measurements was processed to precisely determine the point on which it was stationed. The GNSS system records the triangulation calculation at a measurement rate per second.

Thus, the static method can determine with an accuracy of +-5mm, the Cartesian coordinates of the support point.

b) Establishing work methods with the help of the total station

Trimble S7 total station (Figure 4.) is the instrument for measuring horizontal, vertical angles and electronic distance measurement with the possibility of storing the measured and computed data. The topographic works were carried out by the traverse method supported at the ends simultaneously with the survey of intermediate points for planimetry and terrain details. The tool used to carry out topo-geodetic work, more precisely the total station, automatically performs the compensation of the measurements.

Figura 4. Trimble S7 total station

To download the data, the Terramodel software was used, which is a package of programs with different applications, intended for design work in the field of civil engineering. [7], [8] It includes modules for generating the digital terrain model and contour lines, designing communication paths, computer-aided design (CAD) and various calculations such as (COGO). Each module contains sets of commands, which add specific functionality to the basic capabilities of FDM. Terramodel contains a macro language (TML) that allows the creation of customized commands.

The main features of the Field Data Module (FDM) are geared towards downloading/importing data measured with total stations, calculating coordinates, drafting the original field, including lines and inscriptions, and exporting/uploading data (Figure 5.).

3. RESULTS AND DISCUSSION

The purpose of the topographical survey was to acquire data from the field in order to modernize public electric transport and set up the non-motorized transport infrastructure in the Municipality of Reșita.

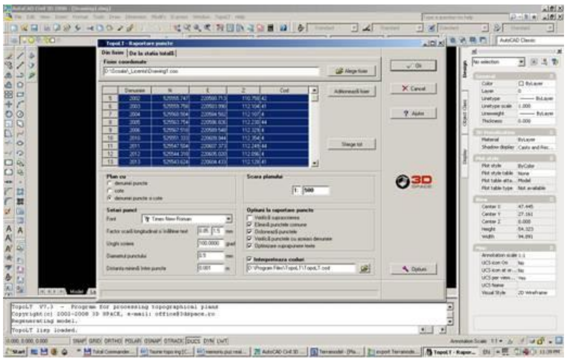
Figure 5. Terramodel software

The total length of the route that is the subject of this project is 8.5 km, this route includes the following streets: Republicii Boulevard, Calea Caransebesului, Calea Timisoarei, Revoluţia din Decembrie Boulevard, Ion Luca Caragiale Street, Libertăţii Street, Traian Lalescu Street, Paul Iorgovici Street and Republic Square (Figure 6).

Figura 6. The total length of the route

This work presents only a section of the urban sustainable development that contains the modernization part of the electric public transport and the arrangement of the electric transport infrastructure of the Municipality of Reșita. From the completed route, the paper presents the first section that includes the portion of the roundabout that connects with the Intim passage and crosses over the railway that connects Reșita Sud and Reșita Nord. (Figure 7).

Figura 7. The route of the studied area

In order to carry out a work of such magnitude, it is necessary to carry out both topographic surveys and drawings. In order to carry out the topographic surveys, it was necessary to go through the following stages: establishing objectives, establishing work methods (recognition and preparation stage); the field stage (carrying out the actual topographic surveys); the office stage which consists of downloading the devices, then processing the data obtained in order to create the topographical technical documentation that will be made available to the designer and the creation of the plans in order to complete the work. A very important aspect was the altimetric survey, which is the basis for the creation of both longitudinal and transversal profiles. In order to execute the layouts, only two stages were followed: the office stage followed by the field stage.

Recognition and preparation stage

Designing with the aim of modernizing electric public transport and setting up the transport infrastructure requires intensive planning on the decisions regarding geometric elements, infrastructure, materials used, methods used for construction, but also its correlation with the regulations in force that refer both to the transport part in common as well as on the road and pedestrian side.

For this survey, the following information was taken into account:

- Improving the geometry of the route in plan and in longitudinal profile (rectification of curves and fitting profile elements into the provisions of the regulations in force)
- Level curves and level differences;
- Geometry of the track in transverse and longitudinal profile;
- Water collection and evacuation works;

- The nature and location of the existing and projected underground and above-ground construction facilities;

- Level passes;

- Systematization of railway line devices in stations;

- Creation of the road system of the streets;

- Level intersections, uneven intersections, industrial accesses, etc.;

- The shape and size of the constructions;

- The size of the transport network (roadway, sidewalks, green spaces);

- The correct operation of the equipment.

Field stage

The support points were previously determined by the static method with the aid of GPS using the reference stations. With the help of the total station, it was possible to survey all the details (road, rails, curbs, poles, canals, etc.) that are the subject of this work in order to realize the necessary plans for a new infrastructure. The traverse and the detail points survey of planimetry and terrain were carried out simultaneously, at the end having as the last station point a support point of known coordinates, with closure on another point of known coordinates.

Concomitant with the survey of planimetric details, the altimetric survey of them was also carried out because the designer expressly requested the scaled plan of the route of the future tram line. That's why during the execution of the traverse and detail points survey, the height of the device was constantly measured with precision and entered into the station's memory.

After carrying out the survey, we moved on to the office stage, more precisely to the actual survey processing, the formation of polylines, polygons and the location of specific symbols, but also the creation of topographic and elevation plans.

Office stage

Field data was downloaded using the computing environment from the Trimble TSC5 GPS Controller to the computer. The format exported from the Trimble TSC5 controller is of the .txt type, this format being compatible with the specialized program TopoLT. This data was imported into the AutoCAD infographic program (Table 1).

The coordinates of the station points determined with GPS **Table 1.**

Nr. pct.	X[m]	Y[m]	Z[m]	Cod punct
i1	255590,5	428908,1	211,601	1
i2	255493,1	428973,7	211,538	1
i3	255421,4	428947,7	211,385	1
i4	255352,5	428822,7	216,818	1
i5	255139,1	428676,8	225,21	1
i6	255366	428799,8	216,849	1
i7	255168,1	428673,6	224,078	1

Data export from the Trimble S7 total station was carried out through the Terramodel software, specific to the Trimble equipment. After downloading the total station and additional travel compensation, the points from Terramodel were exported in ASCII format to be processed with the specialized program TopoLT in AutoCAD, after which the points were joined according to the acquired attributes and the insertion specific symbols.

From the processing of the elevations with the help of the AutoCAD program, the plan for framing the area, the location and delimitation plan, thematic situation plans, necessary for completing the topographical study, resulted.

The location and delimitation plan was made based on topographical measurements and illustrates the essential elements such as: property boundaries, dimensions, coordinates, location of existing or proposed constructions, respectively fixed topographic landmarks used as support points in the creation of technical documentation for each detail of the route the railways (Figure 8-9).

The situation plan (Figure 10) is a conventional generalized or detailed graphic representation of a land surface resulting from the process of measurement, compensation of measurements and processing carried out in the office [6].

Figure 8. Location plan of the traffic circle

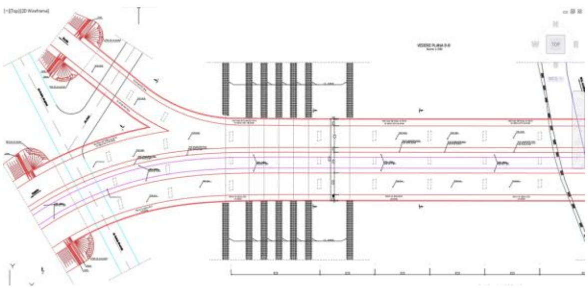

Figure 9. The location plan of the bridge in the Intim area that crosses the railway

Figure 10. Situation plan

The framing plan (Figure 11) represents a section of the cadastral plan and has in its graphic composition the representation of the building for which it is issued in relation to the neighboring ones, on the support of this plan the dimensions of the building and its sides are highlighted as they appear on the date of the last update.

Figure 11. Framing plan of the area

Following the processing of the data taken from the field, both transversal and longitudinal profiles also result.

The transversal profiles (Figure 12) represent the cross-sectional view of the road, for a better visualization of the differences in elevation between the curbs, the road slope, the tram track.

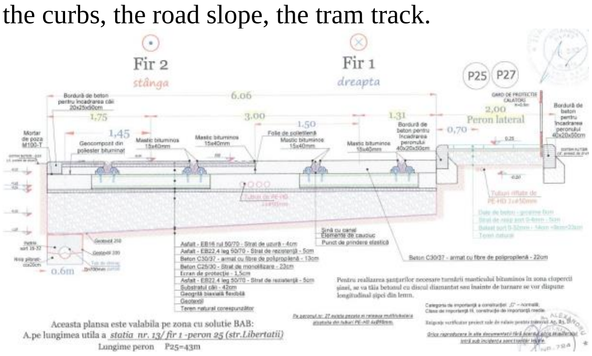

Figure 12. Transversal cross-section

The longitudinal profiles (Figure 13.) represent the differences in height of an element of the lift, in our case, the most important being the tram track.

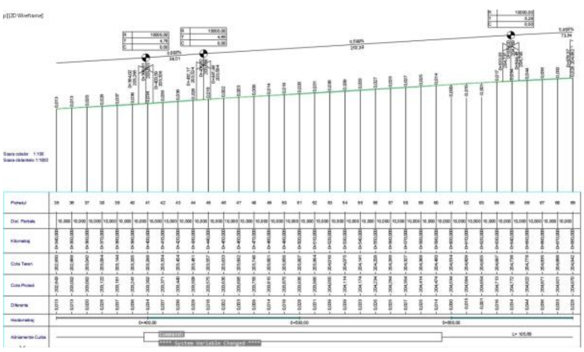

Figure 13. Longitudinal cross-section

Execution stage of the stake out

In order to carry out the work, it is not enough to carry out only the topographic survey, it is also necessary to carry out a stakeout in order to complete the work but also to respect the shape and dimensions included in the project. The data and plans from the designer were received, analyzed and processed in order to draw up the general stakeout plan. The purpose of the layout was to translate the project into the field, which definitively indicates the route of the road, rails, etc. The field materialization of the technical project was carried out according to the layout plans that were created based on the topographic survey and the architectural plans.

The actual stakeout was carried out with the help of GPS, while the stakeout check was carried out with the total station, these presupposing the application on the ground of the corrections resulting from the comparison of the projected values with the measured ones.

The stakeout plans (Figure 14.) contain all the geometric details (length, width, connections, longitudinal axis, etc.) for the entire length of the traffic, for all the platforms and annexes included in the project.

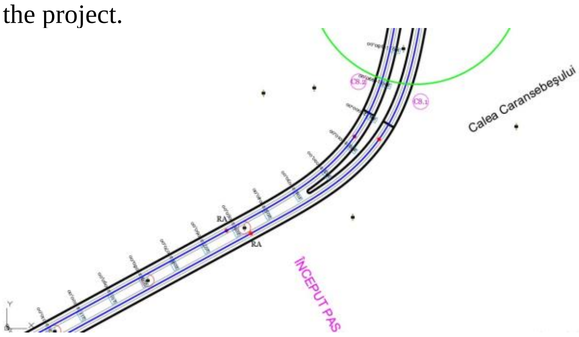

Figure 14. Tram track stakeout plan

These plans help in the actual transposition on the ground of the tram track, curbs, road surface, sidewalks, etc. The elevations of the decks and pickets were drawn based on the longitudinal and transverse sections.

The pickets were positioned at intervals of 10 meters, in the case of the tram track, and 20 meters in the case of the road and pedestrian part. The stakeout was carried out from 50 to 50 centimeters, so the determination of the intermediate elevations of the stakes is performed by interpolating the elevations between the 2 stakes between which we are located [9].

The Trimble R8 GPS has the ability to perform calculations in real time for an intermediate point between 2 stakes of known height, thus no additional calculations are necessary.

These coordinates are correlated with the pickets in the tram track layout plan. The rectangular coordinates x and y are taken from the layout plan of the tram track, and their elevations are taken from the longitudinal profile.

In order to finalize the stakeout, the following plans will be found in the technical project (Figure 15-17):

After preparing the stakeout in the office stage, the actual drawing was done. The plotting was carried out with the help of the GPS using the method of rectangular coordinates.

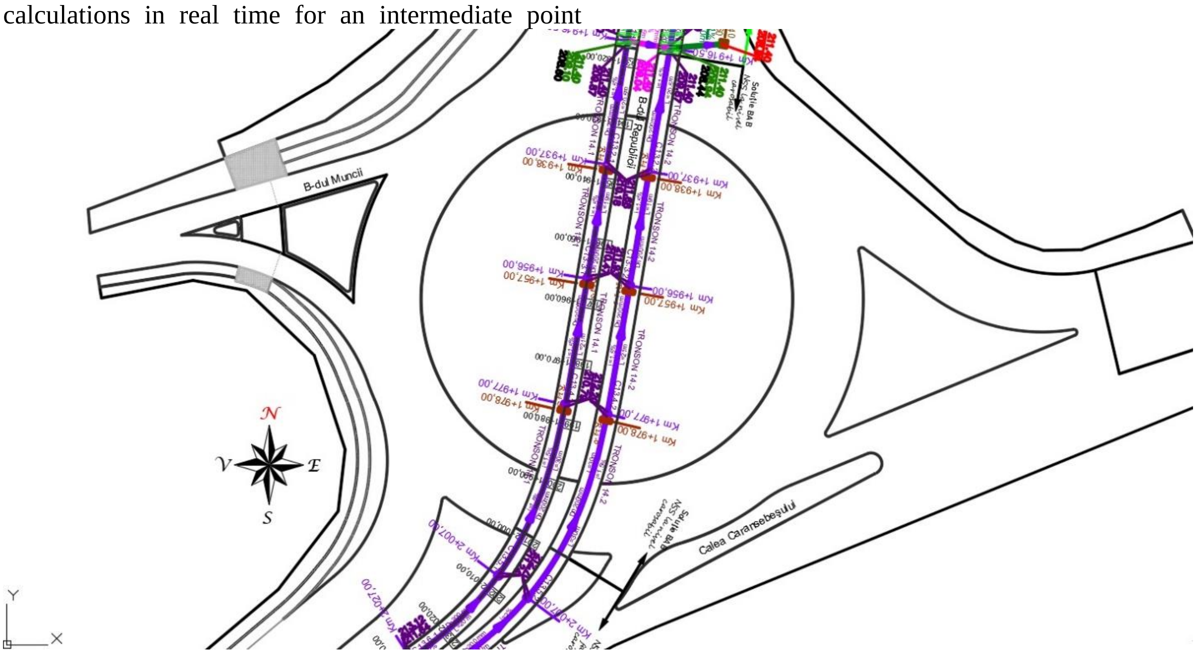

Figure 15. The drain stakeout plan

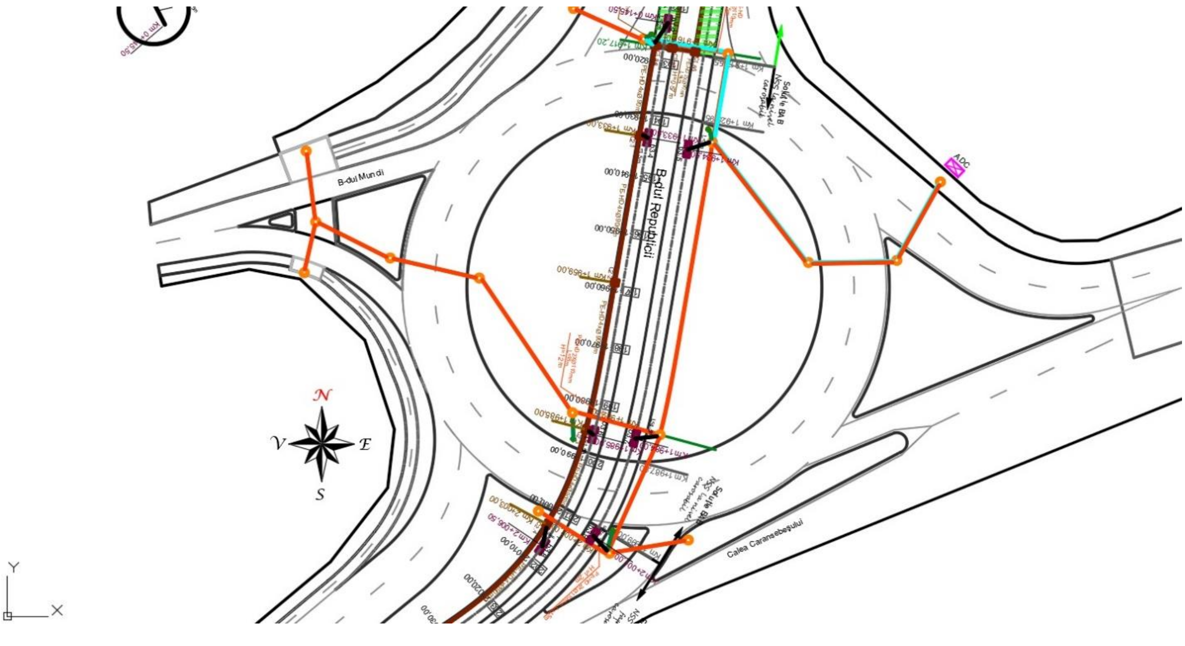

Figure 16. The automation stakeout plan

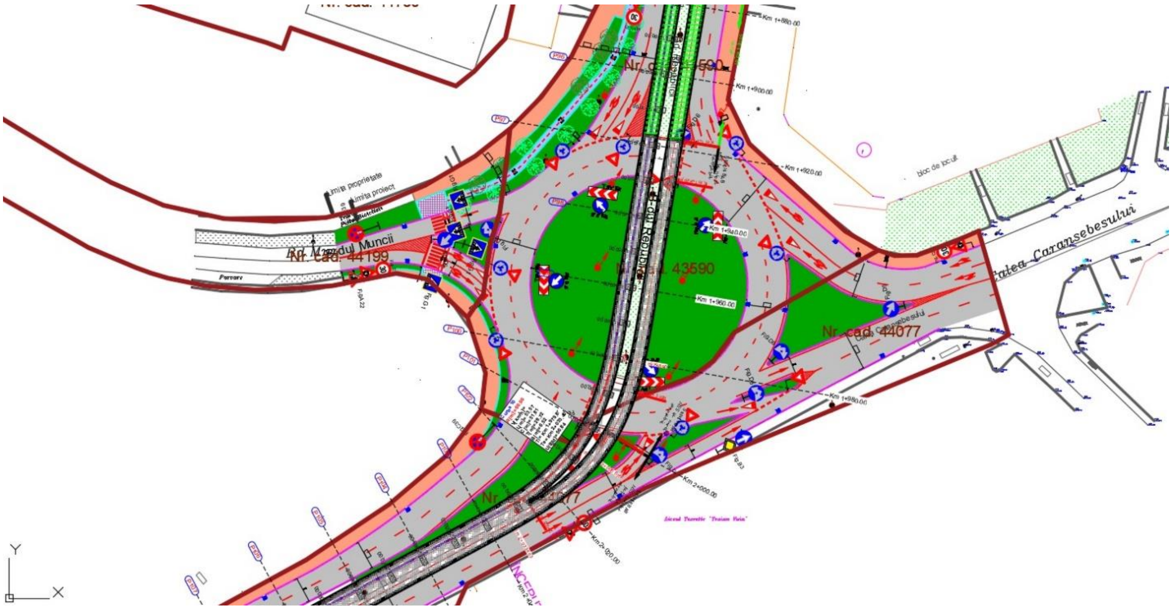

Figure 17. Roundabout Circulation stakeout

After tracking with the GPS, the track check was performed. The plot check will be done by randomly taken coordinates and will be done with the total station by the polar coordinate method. This method involves both angular and linear measurements, the basis of the plot being made up of the points of the traverse made during the topographic survey. This method belongs to the method of polar coordinates, which is essential and even recommended for drawing the axes of roads and railways, drawing the axes of the taxiway, but also of technical-building networks.

4. CONCLUSIONS

This paper presented the use of modern techniques used in a special topographic survey, regarding the modernization of electric public transport and the development of non-motorized transport infrastructure in the Municipality of Reșita.

The methods used in carrying out the survey fully comply with the legislation in force in Romania.

The importance of the training of surveyors for the execution of measurements with high accuracy and in an optimal time was noted, considering the fact that topographical works precede the execution of specialized works.

Topo-geodetic surveys made by the method of traverse supported at the ends is facilitated at the present time by the use of advanced technologies of geodetic instruments with superior working and precision characteristics.

An important aspect was represented by level surveys along the entire route, materialized by successive longitudinal and transversal profiles with a high density for the construction of the roadway and the adjacent embankments.

The appearance of this technology determines a change in the structure of the work procedures that result in obtaining a high degree of automation and an increased yield.

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