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THE TOPOGRAPHICAL STUDY FOR THE UPGRADING OF ELECTRIC PUBLIC TRANSPORT AND THE DEVELOPMENT OF THE NON-MOTORIZED TRANSPORT INFRASTRUCTURE OF THE MUNICIPALITY OF REȘIȚA

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Abstract

The purpose of the topographical survey was to collect data from the field in order to fully upgrade the electric public transport and improving the non-motorized transport infrastructure in the Municipality of Reșița.
The total length of the route that is the subject of this project is 8.5 km, this route includes the following streets: Republic Boulevard, Caransebeșului Route, Timișoarei Route, The December Revolution Boulevard, Ion Luca Caragiale Street, Freedom Street, Traian Lalescu Street, Paul Iorgovici Street and Republic Square.
From the route created for the electric transport infrastructure, the paper presents the first section that includes the part of the roundabout that connects with the Intim passage, that crosses over the railway that connects South Reșița and North Reșița. The study presents the following stages in the fulfilment of the project: the stage of organisation necessary for the realisation of the specialised works, the materials and methods used in carrying out the topographic survey, the processing of the data in order to create the topographical technical documentation that will be made available to the designer.

***Key words**: electric transport infrastructure, situation plan, topographic survey.*

INTRODUCTION

Reșița is the municipality residence of Caraș-Severin county, located in the Banat area of Romania. This municipality consists of the localities: Câlnic, Cuptoare, Doman, Reșița (residence), Secu, Țerova and Moniom. The municipality of Reșița is located in the south-west part of Romania, more precisely in the north-west part of the county, on the middle course of the Bârzava river. The city of Reșița is known as the oldest steelmaking center in Romania. Being an old steelmaking center town, unfortunately the world did not see a potential in it and were not interested in the development of this city, all this until now when the possibility of making a change that will modify and develop this city was found. Already in 2015, a large-scale project was started, both in terms of urban and economic development, which continues to this day. The municipality of Reșița was in great need of a change in order to offer a more sustainable and good future. This work is based only on a section of the urban development that contains the section for the upgrade of electric public transport and the arrangement of the non-motorized transport infrastructure of the municipality of Reșița.

A particularity of the Reșița municipality, created by its location in a predominantly mountainous chain, is the increase in the difficulty of using the GPS system. The difficulty is created due to the reduction of the angle of incidence between the horizon line and the GNSS system receiver, thus the relief obturating the transmission of certain satellite signals. A solution to avoid these reliability problems is the use of the Base-Rover method, which involves placing a GNSS receiver on a known fixed point, which has a larger opening to the horizon, to send the corrections in real time, through radio signals, to the device with which measurements are made (Rover). This method is not affected by the obstacles between the base and the Rover, and the reliability of the signal is superior.

MATERIALS AND METHODS

After analysing the work route, it was concluded that, in order to carry out a correct survey, two work methods are necessary, namely: the GPS method, the topographic survey carried out with the total station.

GPS method. Positioning with the help of GPS technology is achieved by determining the distances between the station point and at least 4 visible GPS satellites. The support points will be determined with the help of GPS using the static method, with the specification that for measurements with the total station, a much larger number of support points is needed. The static method uses the signals received from the satellites and triangulates the position on the globe, after which, the file created with the measurements, is processed for the precise determination of the point on which it was stationed. The GNSS system records the triangulation calculation at a frequency of one measurement per second, also called epoch. If the triangulation rule of at least 4 satellites transmitting to the receiver cannot be respected, it does not perform the measurement.

Figure 1. Receiver Trimble R8s

(https://surprise-cord.squarespace.com/products-1/trimble-r8s-gnss-receiver?fbclid=IwAR39pkbyEl_xx2yMOZUlWgiqzZMy5ZptKen9JajHFeqG-mQbGGWkWnFNdkM)

A Trimble R8s and a Trimble TSC5 controller were used to perform measurements involving GPS. Each Trimble R8s receiver integrates Trimble 360 tracking technology that supports signals from all existing and planned satellite constellations and augmented systems.

The Trimble R8s includes two Maxwell™ 6 processors along with 440 GNSS channels. It is capable of tracking satellite systems including GPS, GLONASS, Galileo, BeiDou and QZSS. Together with the CMRx correction protocol, which offers unprecedented compressed corrections, the safest positioning is obtained.

The Trimble® TSC5 is an Android-based control unit with a 5’’ screen and full keyboard, ensuring fast and efficient operation, even while wearing gloves. Rugged yet lightweight with all-day battery life, the TSC5 is easy to carry and easy to use. Combined with Trimble Access™ software for accurate field data collection, the TSC5 offers the ideal combination of high performance and reliability you have come to expect from Trimble.

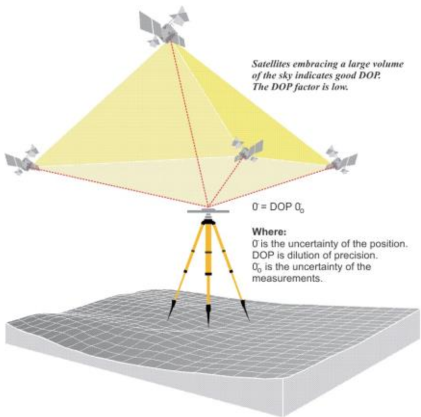

Figure 2. The principle of GPS measurement

(https://www.e-education.psu.edu/geog862/print/l7.html?fbclid=IwAR1Vyghwg5IHCiWuwc9yrd4JAB-vu-Za09HCVrWw1J0L6bR-tkmifC8UW3A)

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

The topographic survey performed with the total station. The total station is used for an increased precision and accuracy. The total station is the device for measuring horizontal and vertical angles and the electronic measurement of distances with the possibility of storing the measured data. Most of the time, the measurements are made by the method of closed traversing.

This method, although very precise, is slow and requires additional processing, as it is necessary to compensate the measurements made with the total station. The determination of the elevations of the support points and the landmarks in the traversing is done with the level by the geometric levelling method.

Figure 3. Total Station Trimble S7

(https://www.giscad.ro/aparat/trimble-s7/?fbclid=IwAR2dm4h17UXzD0aA8_cc2FKGMtVyiEtSOXaeegYVnSv1fTRHJW3_ig-lLYA)

For the total station measurement method was used a Trimble S7. The Trimble® S7 total station combines a number of features such as scanning, land photogrammetry and surveying in one powerful technical solution. The Trimble S7 is an efficient system created for performing topographical measurements that allows you to adapt to any situation in the field, to achieve high productivity. By combining proven SureScan, Trimble VISION™, FineLock™ and DR Plus technologies with many other features, you will achieve the results you want much faster and more accurately.

RESULTS AND DISCUSSIONS

Measurement planning

For this work were established the following topographic objectives:

- Improvement of the geometry of the route in plan and in longitudinal profile (rectification of curves and framing of profile elements in the provisions of the regulations in force).
- Curves and level differences of the land.
- Geometry of the path in transversal and longitudinal profile.
- Water collection and evacuation.
- The nature and location of existing and projected underground and above-ground infrastructure.
- Level crossings over the railway.
- Systematization of railway line devices in stations.
- Composition of the road system of the streets.
- Level intersections, uneven intersections, industrial accesses, etc.
- The shape and size of the adjacent buildings.
- The size of the transport network (roadway, sidewalks, green spaces).
- Correct functioning of the topographic equipment.

The stages of the topographic survey

Designing, with the aim of upgrading the 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.

The feasibility study

This study is a document that presents the projects ability to fulfil certain technical requirements. Before building anything, you need a feasibility study. A feasibility study means a technical-economic documentation that helps the designer to make the best decisions.

The feasibility study is constituted by the topographic measurements and their digitization, which aim to recognise the land for design, and by the geotechnical study which is necessary to establish the elasticity of the bearing layer and helps to establish the bearing capacity of the soil to support the road structure together with the vehicles that will travel on the road, and the vibrations produced by traffic.

Since we are talking about the railway, the topographic elevations must have a certain precision.

Therefore, the Trimble S7 total station was used to perform the surveys.

A Trimble R8s, GNSS system was used together with a Trimble TSC5 controller to determine the support points required for the closed traversing.

Through the static method, the coordinates of the support points in the Stereo 1970 coordinate system formed on the secant plan to the Krasovsky 1940 ellipsoid are obtained with high precision.

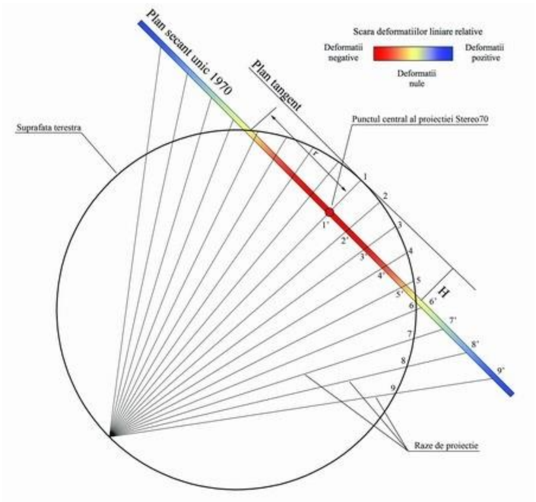

Figure 4. The projection of points on the earth's surface on the Stereographic projection plan 1970

(https://www.topo-online.ro/ro/stereo70.php)

Performing of topographic surveys

As previously mentioned, the closed traversing was used to perform the measurements. This method involved setting up the total station device on a support point previously determined by the static GPS method, and using another support point with known coordinates as the bearing. The traverse and the survey were carried out simultaneously, at the end having as the last station a known support point, from which another point with known coordinates was targeted.

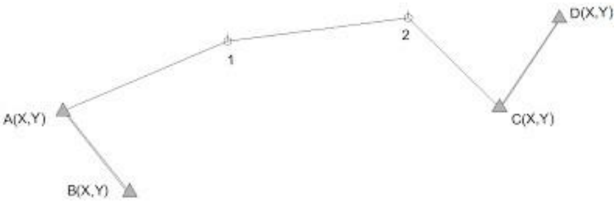

Figure 5. Representation of the method of closed traversing

(https://www.ct.upt.ro/studenti/cursuri/jianu/topografie%202.pdf?fbclid=IwAR1BVEcuNYhD8EjDiFa8JDN7wDtJrXZ8inYmfQiS5DfLIYhg0CXCWk3RQ3I)

So, by closing the traverse on known support points, it was possible to compensate the measurements. After the compensation of the measurements, the elevation processing, the construction of polylines, polygons and the placement of specific symbols represented by conventional signs were carried out in the office stage.

The office stage

From the processing of the elevations resulted location plans that are part of the topographic study.

Figure 6. The location plan of the roundabout

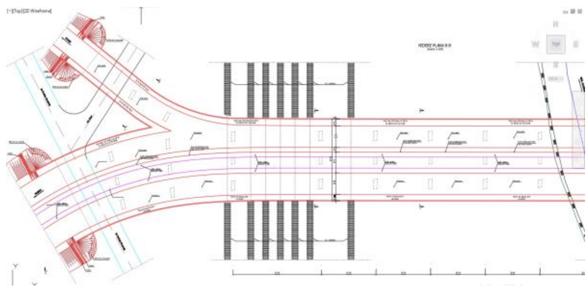

Figure 7. The location plan of the bridge from Intim that crosses the railway

Figure 8. The situation plan

After processing the data taken from the field, both transversal and longitudinal profiles are also obtained. Transversal profiles represent the image in section of the road, for a better visualization of the differences in elevation between the curbs, the road slope, the tramline.

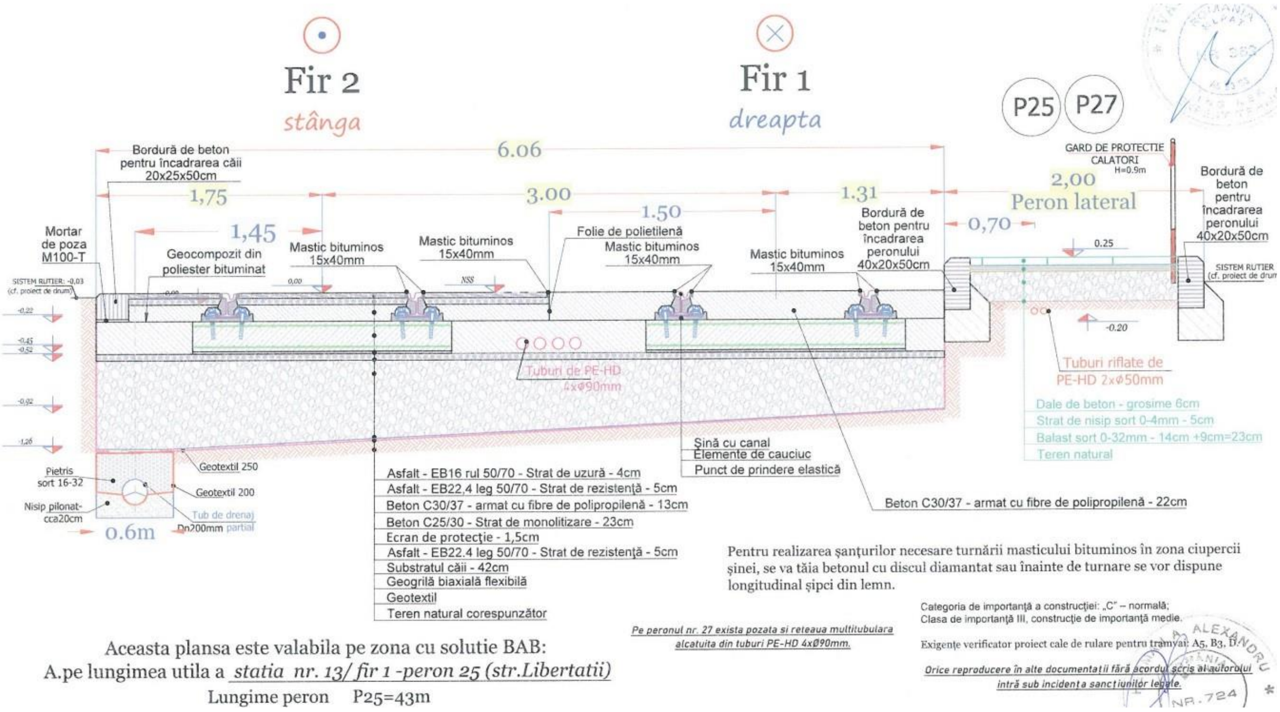

Figure 9. The transversal profile section

Longitudinal profiles represent the differences in elevation of an element in the survey, in our case, the most important being the tramline.

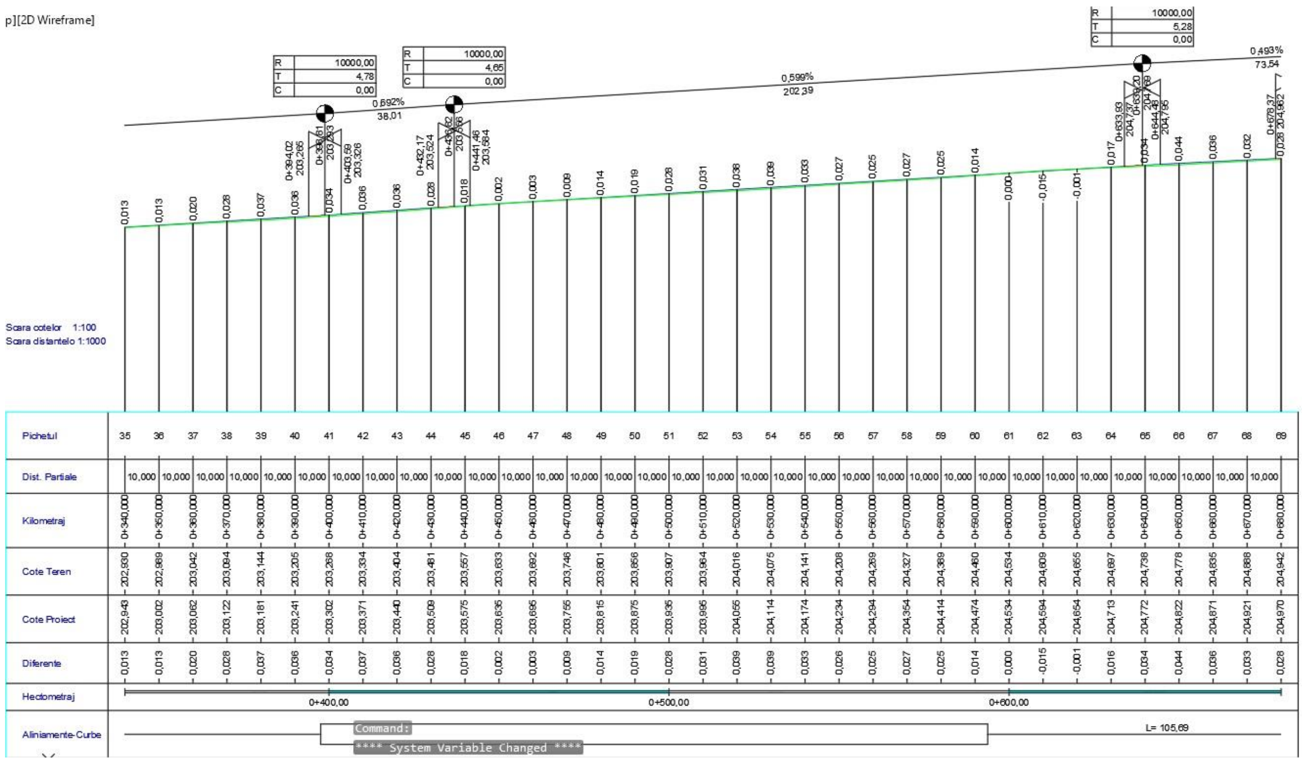

Figure 10. The longitudinal profile section

CONCLUSIONS

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

The methods used in the performing of topographic surveys fulfil the legislation requirements in force in Romania.

The topographic surveys carried out by the method of closed traversing is facilitated at the present time by the use of advanced technologies of total stations with superior working and precision characteristics.

However, this technology requires special attention from the operators and a longer time for the execution of the works in the field.

Data processing requires the use of specialized programs for the accurate creation of longitudinal and transversal profiles, such as TopoLT, ProfLT.

The emergence 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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