IMPLICATIONS OF TOPOGRAPHY IN ROAD BRIDGE INFRASTRUCTURE DEVELOPMENT PROJECTS

Ioana Aurica BERINDEIE, stud., „1 Decembrie 1918” University of Alba Iulia, Romania, ioana_berindeie@yahoo.com
Luciana OPREA, Assoc. Prof. Dr. Eng., „1 Decembrie 1918” University of Alba Iulia, Romania, lucii_oprea@yahoo.com

***Abstract**: The sustainability of the structures is a problem faced by the administrators of the road networks, both in the sphere of the academic community and of the technical staff responsible for the maintenance of the bridges.*

In this context, this research topic analyzes the complex of works necessary to achieve an engineering structure of major importance for society. The novelty and the opportunity to approach this desideratum derive from the need to realize these structures necessary for the development of the road infrastructure but also to ensure the connections between the isolated areas due to the different impediments of the relief in the area.

***Keywords:** topographic works, bridge, digital model, topographic plan.*

1. Introduction

The importance of dealing with this subject dates back to ancient times, drawing attention to the words of the scholar Isaac Newton who said: "People build too many walls, but not enough bridges."

Bridges have been created and developed continuously since ancient times. Their evolution throughout history has been influenced by the development of human society in every associated social organization.

In the last 30 years, our country has felt the urgent need to develop infrastructure, Romania being still considered the country with the weakest infrastructure in the European Union.

The infrastructure is represented by the structure and the basic components necessary in a field of activity:

- Functioning of the company: laws, norms, regulations;
- Constructions: foundation, resistance structure;
- Transport: components.

The development of the Romanian infrastructure by building efficient communication routes, in different development regions of the country, would mean a positive effect on the local and national economy. Building a wide network of roads that connect with the rest of Europe would be attracting new investors to our country. Under these conditions, the roads could not be built without providing engineering complexes that connect two isolated sections.

According to the terminology, the bridge is defined as a "construction that supports a transport path over an obstacle, leaving a free space to ensure the continuity of the obstacle crossed"

The project of this paper was designed to build a new access road, being an integral part of a project to develop urban mobility. The usefulness and importance of this project lies in the fact that since 1980 and until now the „brudina” are used, which are unapproved floating platforms and which are used due to the lack of a bridge over a river, in this case the

Mureș river. The selection and presentation of the study will guide the understanding of the essential methods currently used to create 3D models of bridge constructions.

Fig. 1 Brudina on the Mureș River

2. Materials and Methods

The construction of the bridges evolved from primordial forms that used mainly building materials existing in nature (stone and wood), to the modern forms encountered today made of concrete, respectively steel or combinations of the two materials previously mentioned.

As part of the category of works of art, bridges can establish economic relations between different areas. Moreover, they facilitate the transport time of goods and people, thus also contributing to economic growth.

In general, the structure of the bridges consists of:

- superstructure - the upper part of the bridge, having the role of taking over the loads from the traffic. It consists of the running track and the resistance structure (with the role of supporting the previously mentioned component);
- infrastructure - the component of the bridge that takes the loads from the superstructure and transmits them to the foundation ground. The structural elements are represented by abutments and piles;
- the area related to the bridges - is the place where the bridge is connected to the embankment. The conformation is made of wings, cone quarters, connecting plates, drains, access ramps.

In order to build the proposed civil construction, the requirements of functionality, strength and stability of the structure, as well as aesthetics, were taken into account and observed. The decision was made after analyzing the positive and negative factors that influence both the building and the inhabitants of the environment.

At the same time, the loading class of the bridge was studied, and it was imperative to sustain considerable efforts of the vehicles, especially those used in the agricultural industry, with high loads. Having the role of serving heavy traffic, the bridge is an investment suitable for the agricultural market, given the fact that the northwestern part of the town is arable land. At the same time, the geometric and loading parameters of the communication route were taken into account and thus it was agreed to determine the route by avoiding the areas of curve or counter-curve, having the right trajectory. On the other hand, the decrease of the arable land area under the new structure influences the ambiance of the natural environment.

The topographic studies carried out on the engineering construction in this case are essential to ensure the correct arrangement of the bridge on each side of the river. Minor measurement errors spread across the entire length of the bridge can mean significant deviations from the final work.

The surveyor is involved in all stages of a project: from measuring the land, to checking the construction of buildings and framing in the project, to the completion of the work where it is ensured that the whole follows the original plans.

Addressing this issue is of major significance, both nationally and internationally, as evidenced by the economic, political and social aspects of a society.

After consulting the documentation provided by the Office of Cadastre and Real Estate Advertising Alba and Blandiana town hall could not identify three geodetic points located in three different quadrants in the area of the studied area, which is why six points were used by technology modern GPS using the static method.

The bollards were placed before the start of excavations and site works outside the work area, in order to avoid their deterioration. They have been designed in such a way as to ensure mutual visibility between them, in order to make it possible to orient from any station point on three other terminals, determining the fourth, regardless of position, because the level differences are insignificant at existing natural land.

In the measurement and network planning phase, the terminals were arranged in the form of a chain of triangles and determined using the total station. We developed the topographic network in the field works phase, and the same terminals will be used for tracing.

Based on the project, we extracted the axis drawing coordinates, the planimetric coordinates and the depths required for the excavations for piles and abutments. At the same time, I took the sample of the project which was later drawn for the delimitation of the work area. Thus, the preliminary data were prepared for the actual execution.

3. Results and Discussion

The preliminary operations necessary for the elaboration of the project include a logical sequence, which is to be presented. First of all, the formalities for starting the works were drawn up. These consist in obtaining the report of delivery-receipt of the site accompanied by the report of delivery-receipt of the topographic landmarks from which the initiation of the work took place. The second step was to procure the tools, materials and data needed for the work.

PROCES VERBAL DE PREDARE-PRIMIRE A BORNELOR TOPOGRAFICE

Construire pod peste Râul Mureș

Trasarea a fost executată pe baza planșelor din proiect nr. 436/2018.

Elementul de reper pentru verificare este borna B10100 și B10101 – borne noi marcate în teren în data de 15.01.2021.

B10100	X=496007.335	B10101	X=496050.974
	Y=373465.043		Y=373465.043
	Z=207.715		Z=207.777

Având coordonatele

	X=496042.258	X=496046.586
	Y=373421.983	Y=373431.059
	Z=208.078	Z=208.098
	X=496043.697	X=496042.412
	Y=373403.964	Y=373403.896
	Z=208.009	Z=208.011

Fig. 2 Minutes of delivery-receipt of topographic landmarks

The working methods used were those of techno-drafting of topographic plans in the CAD environment with the help of the adjacent programs TopoLT, ProfLT, CAD Tools.

Realization of the topographic plan of the studied area

In this paper, the topographic plan resulting from the analytical and graphical processing of data was used to provide information on surface unevenness. Following the analysis of the level curves, decisions will be made regarding the excavation site. Moreover, by determining the end points (maximum and minimum) a convenient way of draining the hydrographic network will be used.

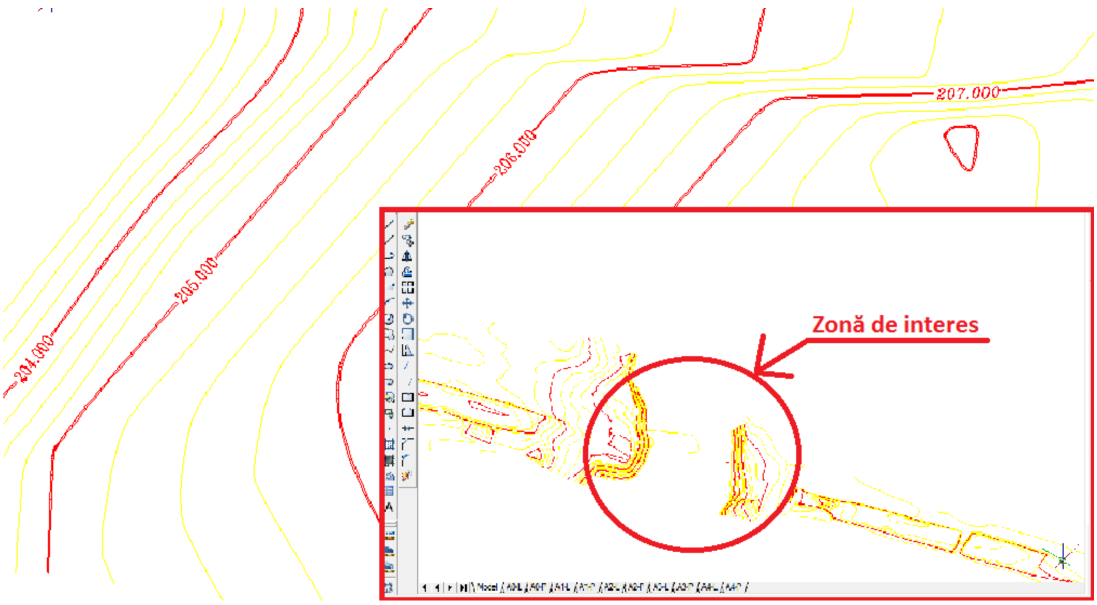

Fig. 3 Level curves related to the studied area

As a result of the existing slopes in the field, in order to report as accurately as possible the configuration of the topographic surface, we chose a equidistance of the level curves of 25 cm between the main curves and 6 cm between the secondary isohypses.

Modelul digital al terenului pentru terasament

A first part of the realization of the digital model of the field is the representation in 3D format. The necessary and sufficient condition for a 3D modeling is that the points, lines or polylines used are in the 3 dimensions (length, width and height). Once this condition is met, a 3D analysis of the digital plan can be treated.

The 3D model was made using different colors, depending on the height of the terrain. The purpose of the three-dimensional representation of the area of interest is to examine the slope of the land. Also, viewing a situation plan in these dimensions is much more effective than a two-dimensional (2D) plan.

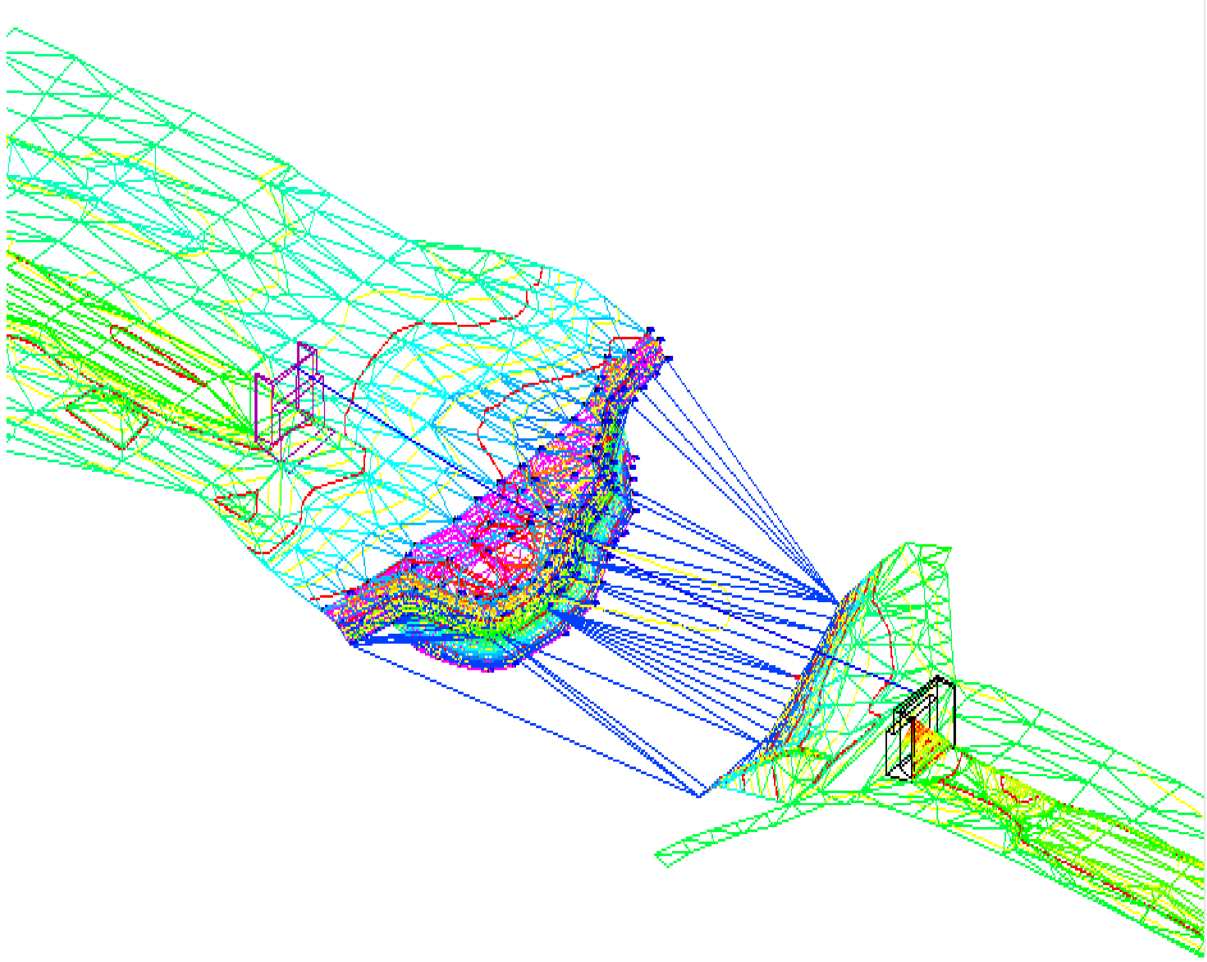

Fig. 4 3D representation of the bridge and the area of interest

Using plans that have 3D points or contours, you can create, through interactive functions, the Digital Terrain Model - MDT. Its role is to facilitate the correlation with the initial project based on the measurements of the elevations in the field.

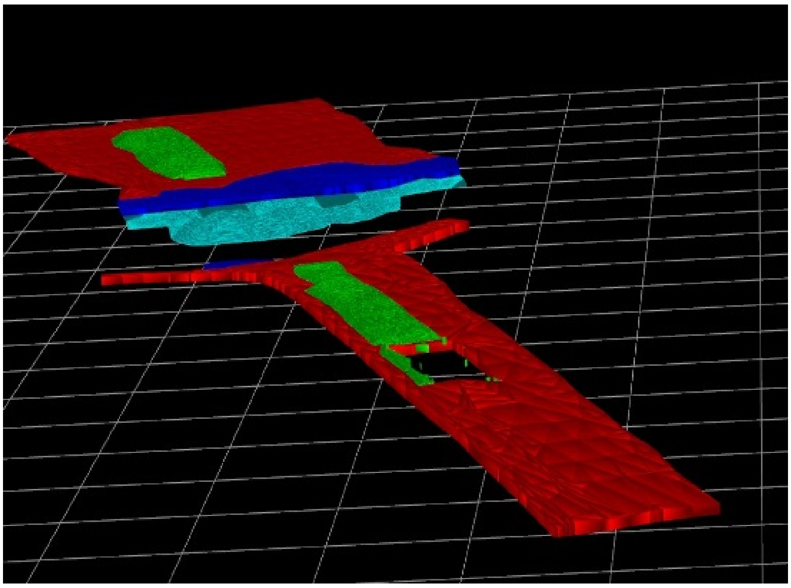

Fig. 5 Digital terrain model

Volume calculation

One of the most important elements of infrastructure works is highlighted by an accurate and reliable calculation of the volume of earthworks. In our case, the target is the evacuation of the non-compliant material filling in the road surface and the necessary volume of excavation for the redevelopment at the initial stage of the riverbed, both sub-points being provided in the specifications.

Based on the digital model resulting from previous measurements and graphic processing, the volume of excavation and drainage materials for the bridge area was generated, as well as the digital models related to these works.

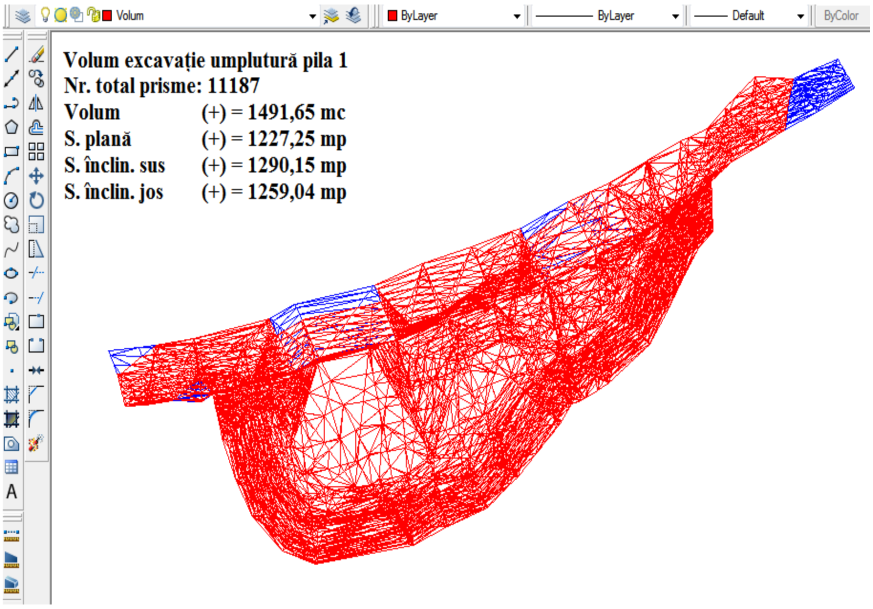

Fig. 3 Calculation of excavation volume fill pile 1

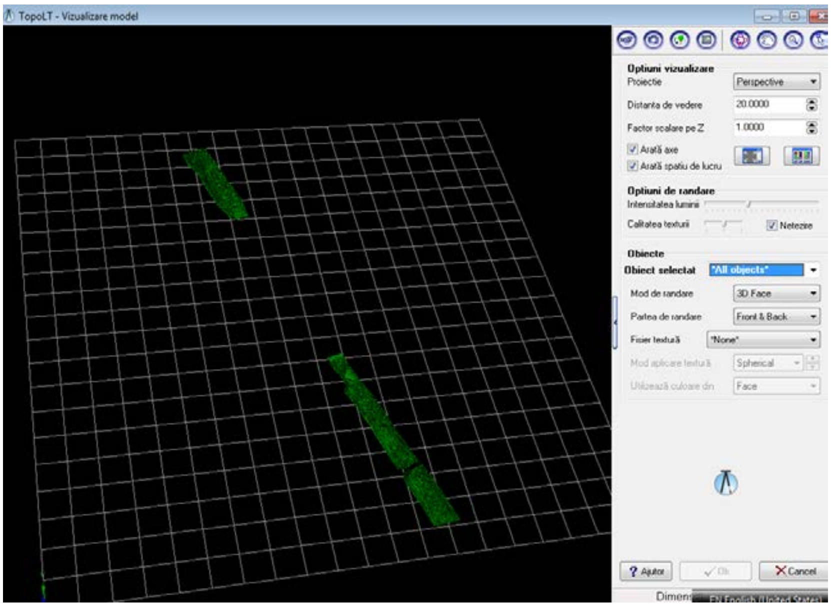

Fig. 7 The 3D model of the material to be discharged

Bridge survey

In order to further develop the construction, the survey was carried out by detailing the existing structural part of the bridge. Its purpose is to provide an overview of constructive decisions, as well as to verify compliance with the scope of the project.

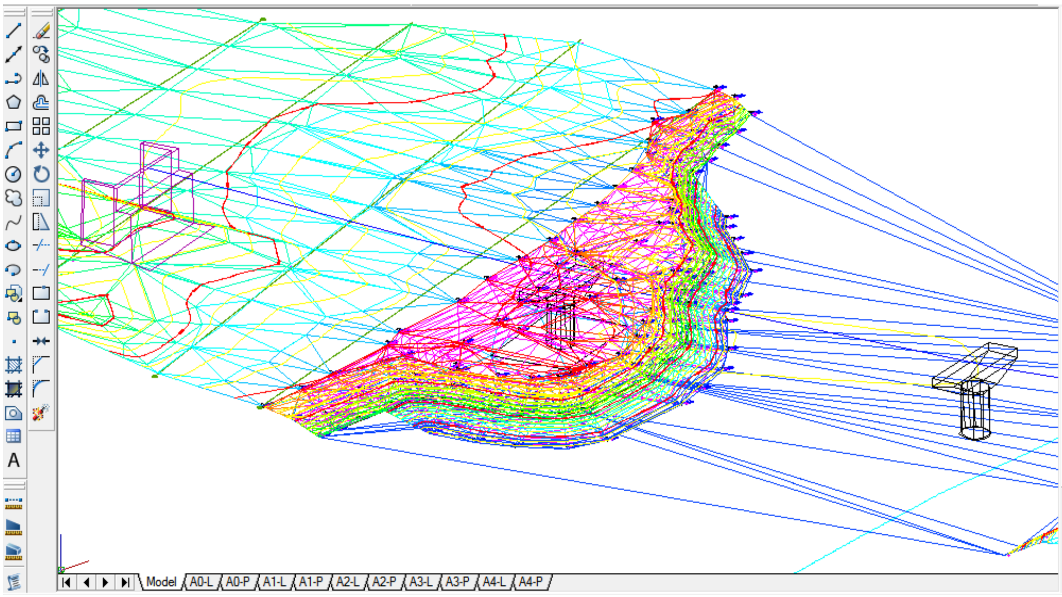

Fig. 8 Bridge survey

4. Conclusions

Topographic studies carried out on engineering constructions of any kind are essential to ensure the correct disposition of these objectives. In this case, it is very important that the works be developed on each side of the river, because the small measurement errors distributed along the entire length of the bridge can mean significant deviations from the final work.

Part of the subsequent work on the actual execution of the infrastructure work is the responsibility of the surveyor and these consist of tracing the locations of the constituent elements of the bridge (abutment, piles) and in-situ design of adjacent works (peninsula and riverbed changes) in order to execute the files. In addition, the correctness of the three-dimensional geometry of the construction elements must be ensured by drawing the elevations according to the design, correlated with the stage of the work and the requirements of the person in charge of the work.

Subsequently, measurements will be made for the post-execution board in order to receive the works and verify them. At the end, tracking marks will be installed that will be used to track the behavior of the construction for the period of operation.

Therefore, the finality of the activity of a surveyor in the construction of bridges marks the standard of living and evolution of a company.

5. Acknowledgments

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