ADAPTATION OF RAILWAY MOBILITY SYSTEMS TO CURRENT NEEDS THROUGH TOPO-GEODESIC TECHNIQUES

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***Abstract**: The remarkable evolution of society requires the adaptation of the existing transport systems, simultaneously with the modernization of the transport infrastructure. This activity becomes imperative to meet the new demands of the population, especially in terms of urban mobility. The object of this study is actually the use of topographical techniques in urban mobility projects, serving both road and rail traffic.*

These projects not only respond to the needs of urban mobility, but also redefine the topographic configuration of cities, optimizing vehicular flow and facilitating complex interactions between relief and infrastructure.

***Keywords:** railway mobility; topographic techniques; topographic plan; railway superstructure; longitudinal and transversal sections*

1. Introduction

The specific topography of the land plays a crucial role in the configuration and performance of railway works. The proposed study analyzes in detail the relief and topographical characteristics of the above-ground area in order to identify feasible and effective solutions in railway infrastructure modernization projects. The railway infrastructure along with the passages, bridges and tunnels, essential elements of this area, require continuous adaptation to comply not only with technological developments, but also with the particularities of the terrain.

This research does not stop only at the technical aspects, but also extends to "digital terrain modeling" to perform accurate simulations and to test the effectiveness of the proposed solutions in the specific context of the topography of the analyzed location. This advanced engineering approach aims not only to optimize costs and operational efficiency, but also to minimize environmental impact.

Thus, the research offers a comprehensive engineering perspective on the modernization of works of art in the specific topographical context of railways, highlighting the importance of integrating advanced technologies and adapted solutions to ensure a high-performance and sustainable railway system.

2. Materials and Methods

The formation of the railway is carried out at ground level, according to the designed alignment and the zero level of the land in the situation where it is at the same altimetric plane as the axis of the rails. In the event that the relief presents a negative level difference, the construction of an artificial mound is required, while, in the case of a positive level difference, excavations or earthworks are resorted to.

In the formation of the railway, each layer has a crucial role in ensuring the functionality and stability of the entire railway infrastructure. The accompanying figure illustrates its composition, and at each stage of the process, the topographic engineer intervenes with precision, resorting to leveling to achieve the necessary standards and specifications.

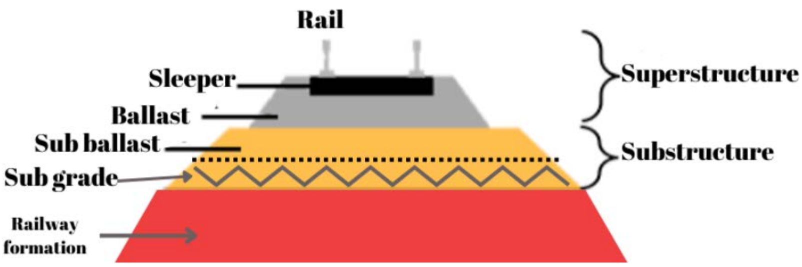

Fig. 1 Stratigraphic illustration of the railway structure (Railway formation, substructure and superstructure - Civil Engineering Tech, civengtech.com)

The constructive solution chosen for the execution of the proposed objective requires the use of the Trimble R8S RTK GNSS system with TSC5 field card and the Leica TCRM1201 total station.

GPS measurements were carried out in order to determine the constructive elements of the superstructure of a railway passage. Thus, the elements necessary for the preparation of the detailed plan of the railway track configuration were measured. At the same time, in this stage, the method of filling new terminals arranged in such a way as to facilitate the lifting of the defining elements of the railway was carried out.

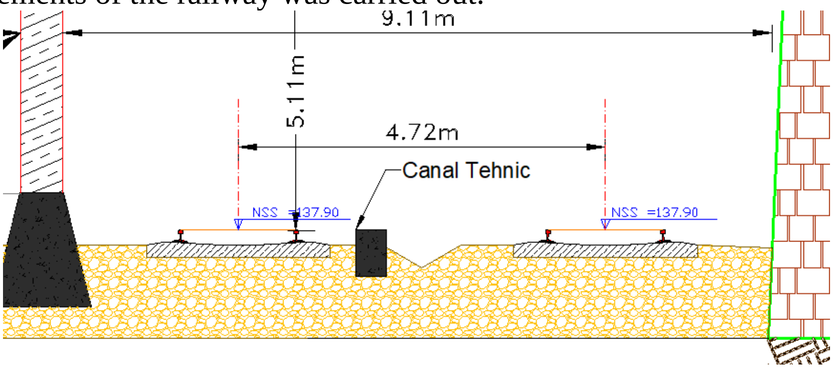

Fig. 2 - Cross-sectional representation of the railway track

The technical channel of a railway represents a sector intended for the alignment and management of various installations and equipment essential for the efficient operation of the railway infrastructure.

From a topographical perspective, the technical channel houses the cable networks used to supply electricity to traffic lights and other signaling devices. It also includes pipes for drainage systems and the transport of necessary fluids, such as water or hydraulic oil. This area serves as a dedicated space for the optimal placement and organization of essential equipment for the control and monitoring of rail traffic. It is crucial to maintain the integrity of this channel to ensure the smooth operation of the entire railway system.

After the completion of the construction of the broken stone prism, a process of topographical measurements will take place to verify that the dimensions and widths of the executed platform comply with the tolerances specified in the Task Book. In addition, an assessment of the planned cross slope in the curved sectors and the level of the rails will be carried out. This process ensures compliance with technical requirements and provides certainty that the execution corresponds precisely to the original design.

Fig. 2 Broken Stone Prism

Catenary poles are placed with a precision calculated within the topographical processes to ensure the correct distance between the contact cables and the trains. In curved areas, they are designed according to the geometry of the railway route, and in situations of uneven terrain, topographical processes contribute to their regulation to maintain a constant distance. Modern surveying technologies are used to avoid collisions and monitor tilt, vibration and interaction with the environment.

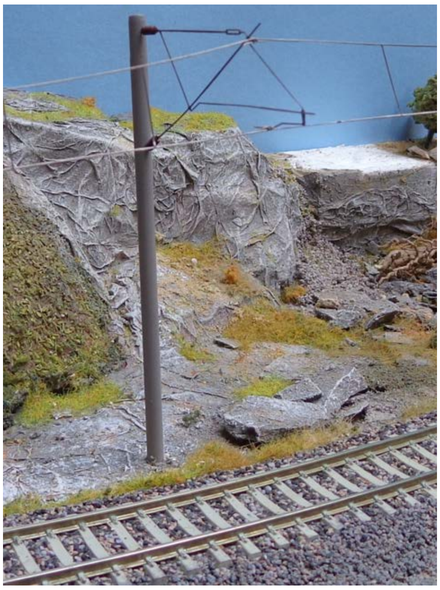

Fig. 3 Catenary poles

3. Results and Discussion

Topographical measurements return to the foreground in the processes of designing and modernizing railway infrastructure, representing an essential component in the accurate determination of heights, alignments and other topographical features. This information becomes imperative for geodetic analysis of foundations, ramp calculation, curve design and other decisive aspects of railway routes. Thus, the digital model of the land is obtained, which facilitates the study and calculation of the construction of the artwork.

As far as railway traffic management is concerned, topographical technologies allow the implementation of advanced signaling and control systems, based on accurate positioning data. This approach translates into more efficient train coordination, reducing the risk of collisions and delays. Topographic data provides a rigorous three-dimensional representation of terrain and infrastructure, providing essential information for the rail traffic control system.

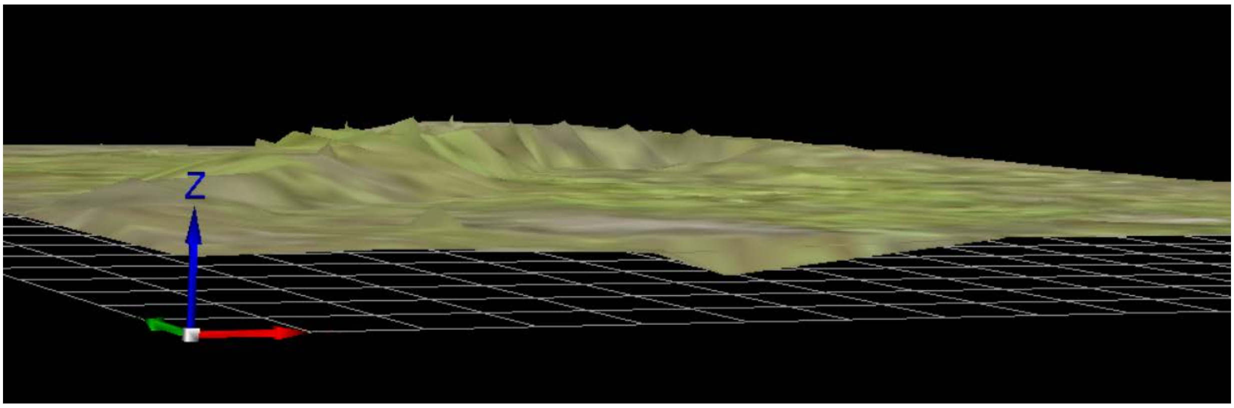

Fig. 4 The 3D model of the land in the area of interest

Preparation of longitudinal and transverse sections

The longitudinal section represents a significant data matrix that illustrates the three-dimensional configuration of the railway and also provides a detailed analytical approach to critical technical and functional aspects. Through these sections, the essential requirements imposed by modern developments in the railway infrastructure are revealed.

In parallel, the cross-sections provide a comprehensive analysis of the overall picture by providing essential information regarding the components of the railway infrastructure such as the railway tracks and the platform. Understanding the transversal details becomes essential to ensure efficient and sustainable design within the railway infrastructure.

The figures associated with these sections represent basic components of topographical analysis. By means of them, not only a visual representation of the infrastructure is obtained, but also an analytical perspective of its interactions with the design variables.

The longitudinal and transversal sections are not only schematic representations, but topographical plans that guide the design of a future adapted, efficient and sustainable railway system.

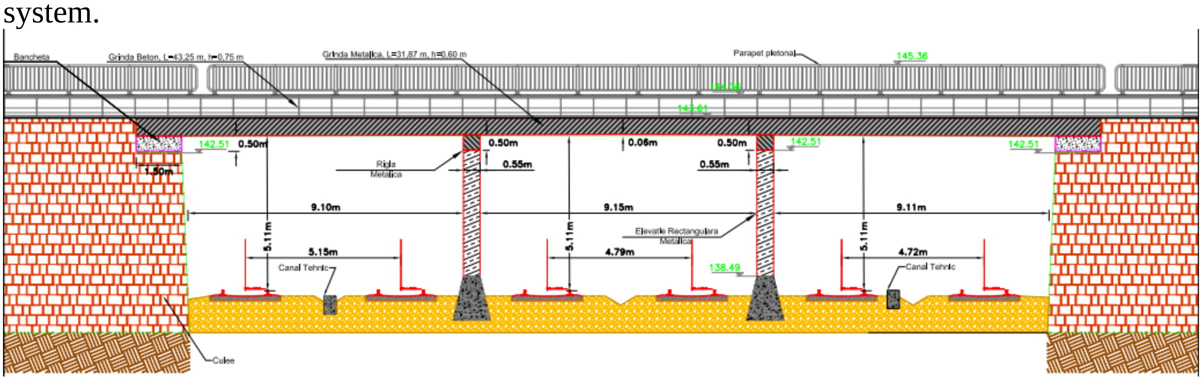

Fig. 5 Longitudinal section of a railway crossing

In this study, a special concern is given to the determination of the existing connections and the gauge gates. These aspects are essential elements in ensuring an efficient and safe railway infrastructure.

Determining the connections to the existing requires the correct evaluation of the interactions and connections between the existing railway routes and the planned or modernized ones in order to exhibit a linearity in three-dimensional space of the running track. In this sense, precise measurements were made to ensure the proper alignment of the new routes with the existing ones. This is particularly important to avoid possible discrepancies or conflicts in the places of intersection of the routes, contributing to an efficient and fluent integration of the new segments in the existing railway network.

In parallel, the theme of adaptation to current needs also involves the management of gauge gates. This will determine the maximum heights allowed for railway vehicles. This approach is essential in preventing collisions or damage to vehicles and other infrastructure elements, thus ensuring the safety and proper functionality of the rail network.

In order to reproduce in a faithful and precise manner an overview of the real situation in the field, the situation plan was drawn up in which the planimetric details are found, and the altimetric details are presented in the section noted on the plan (Fig. 6). By incorporating planimetric details, the surveying engineer gains a detailed and accurate perspective on the horizontal distribution of significant land features such as tracks, platforms, and adjacent structures. This information is a crucial aspect in the design of railway routes, the corresponding alignments and, in general, in the optimization of the spatial configuration of the infrastructure.

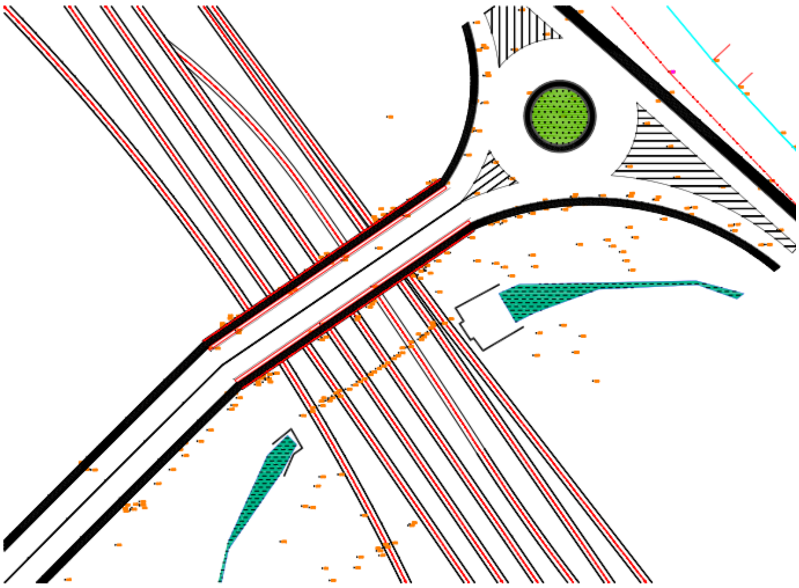

Fig. 7 Topographic plan related to the area of the area of interest

4. Conclusions

Optimizing rail mobility systems in accordance with current requirements, through the application of topo-geodetic technologies, implies a revolutionary paradigm in the approach to measurements, monitoring and management of land and railway routes. From the topographical perspective, this evolution brings with it a significant transformation in the way of acquiring and exploiting topographical data in the railway field.

In conclusion, the adaptation of railway mobility systems to topo-geodetic techniques constitutes an innovation of significant importance in the context of improving the precision and efficiency of the processes of design, construction and management of railway routes. This perspective not only optimizes the existing infrastructure, but also prepares the foundation for future rail mobility, characterized by intelligence, safety and sustainability.

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