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THE USE OF MODERN TECHNOLOGIES FOR THE EXECUTION OF CIVIL AND INDUSTRIAL CONSTRUCTION WORKS

Alexandru Marian Gabriel COSTINAȘ¹, Mihai HERBEI¹, Adrian ȘMULEAC¹

¹University of Life Sciences" King Mihai I" from Timisoara, 300645, 119, Calea Aradului, Timisoara, Romania
e-mail: adrian_smuleac@usvt.ro

Abstract: The civil and industrial construction works, which include the topographic survey of the land and the staking of the construction elements, were carried out using modern equipment to ensure the necessary precision. In the case of the civil construction, which consists of three buildings with a basement, ground floor, and four stories, the topographic surveys were performed with the help of a Trimble R8 GNSS GPS, which allowed obtaining precise measurements due to its compatibility with several GNSS networks (GPS, GLONASS, Galileo, BeiDou). The staking of the construction elements was carried out with a robotic total station Trimble S7, ensuring efficiency and precision. For determining the elevations and performing the leveling, a Leica Sprinter 250M digital level was used. For the industrial constructions, the topographic survey of the land was also performed with the GNSS Trimble R8 GPS, and the staking of the prefabricated elements was done with the same robotic total station Trimble S7. The Leica Sprinter 250M digital level was used for establishing the elevations. All elevations were referenced to the project's elevation 0, which is defined by a specific value, tied to the level of the Black Sea, thus providing a well-established reference point. The obtained data was processed and organized in AutoCAD for a clear and detailed representation of the works. The coordinate system used was Stereographic 1970, and the final data processing was done in AutoCAD to ensure an accurate result.

Key words: GNSS, Trimble R8, Trimble S7, Leica Sprinter 250M, AutoCAD, civil constructions, industrial constructions, Stereographic 1970.

Introduction

In recent decades, the field of surveying has seen a significant shift from the use of traditional equipment, such as theodolites and optical levels, to cutting-edge technologies. These incorporate GNSS (Global Navigation Satellite System) systems, robotic total stations, and digital levels, which greatly enhance the accuracy and efficiency of measurements. This transition has been essential to meet the increasingly complex demands of modern civil and industrial construction projects (Kennie, 2014). The adoption of modern equipment, such as the Trimble R8 GPS, Trimble S7 robotic total station, and Leica Sprinter 250M digital level, has revolutionized the way on-site measurements are conducted, offering increased precision and operational flexibility. Compared to traditional methods, these instruments enable quick data collection and simplify processes, optimizing every stage, from design to execution. The Trimble R8 GPS is a high-precision GNSS receiver (Fig. 1.a), used for establishing geodetic reference points and performing high-accuracy measurements in various terrain conditions. This device is essential in surveying for obtaining precise data, crucial in construction and infrastructure (Vu et al., 2023). The Trimble S7 robotic total station (Fig. 1.b) combines the advantages of traditional total stations with automated functionalities, enabling remote control and 3D measurements. It is ideal for stakeout and monitoring of sewer networks, roads, and other structures, where accuracy and efficiency are essential (Copley, 2019). The Leica Sprinter 250M digital level (Fig. 1.c) is used for leveling and determining elevations, valued for its high accuracy and ease of use. Replacing the classic optical level, it allows rapid data recording and is useful in work requiring precise height measurements (Sălăgean et al., 2017).



Material and method

Each stage of the measurement process plays an essential role in obtaining precise data and ensuring the accurate execution of the project. Therefore, civil and industrial construction sites are divided into three main stages (Fig. 2):

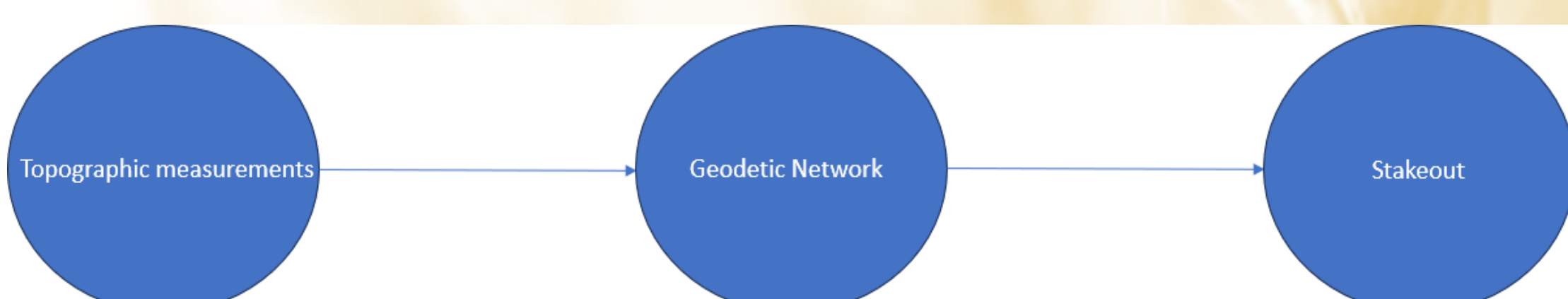


Fig. 2 Cronological steps of workflow in construction field

The initial topographic survey, the creation of the geodetic network, and the execution of stakeouts, along with as-built surveys. The initial topographic survey represents the foundational stage in the construction design process, involving the collection of comprehensive land data using modern surveying equipment. This includes identifying and recording key points of interest, measuring distances and angles, and documenting the area's geomorphological characteristics. These collected data points form the basis for the entire construction design, providing a thorough understanding of the terrain conditions, which are essential for accurate planning and successful implementation of the project (BOTNARU, 2024). The creation of the geodetic network is another crucial stage, requiring the establishment of a system of highly accurate reference points that coordinate all subsequent measurements on-site. This involves determining each reference point's precise position through advanced GNSS measurement techniques, which helps ensure the accuracy of collected data and facilitates the exact stakeout of the project's design on the terrain (Moldoveanu, 2004). Stakeouts then mark the outlines and structural components on the ground according to the design plans, verifying that the project is implemented precisely as intended. Following this, as-built surveys are conducted to compare the completed structure with the original plans, thereby confirming conformity and quality of the executed work. These final measurements serve as essential project documentation and provide critical insights for any necessary adjustments to maintain the accuracy and integrity of the construction (Bondrea et al., 2016).



Conclusions

The significant impact of modern measurement equipment on the precision and efficiency of surveying work is evident. The transition from traditional instruments, such as theodolites and optical levels, to advanced GNSS systems, robotic total stations, and digital levels has demonstrated that these technologies not only improve measurement accuracy but also facilitate the automation of processes, thus reducing time and resources required for construction project execution. By implementing GNSS technology for the initial topographic survey and establishing the geodetic network, an efficient correlation was made between the designed data and the actual conditions of the terrain. At the same time, the use of robotic total stations allowed for automated measurements and remote control, thus increasing efficiency in managing construction sites. Digital levels contributed to ensuring precise and rapid measurements, facilitating the leveling process and optimizing the execution of works. The study area included various construction sites in Timișoara, Arad, Bărzăva, and Oradea, demonstrating the applicability of these technologies in different terrain conditions. In conclusion, the adoption of modern technologies in the field of surveying not only meets the current demands of the industry but also represents a crucial direction for the future of civil and industrial construction, with the potential to revolutionize the way design and execution work is carried out.

Results and discussions

The Trimble R8 GPS receiver was used for the initial topographic survey, (Fig. 3) gathering terrain data and establishing four control benchmarks (Fig. 4) in the Stereo 70 coordinate system. RTK corrections from ROMPOS fixed stations achieved ± 2 mm horizontal and ± 3 mm vertical precision after 15 minutes of stationing and 900 observations.

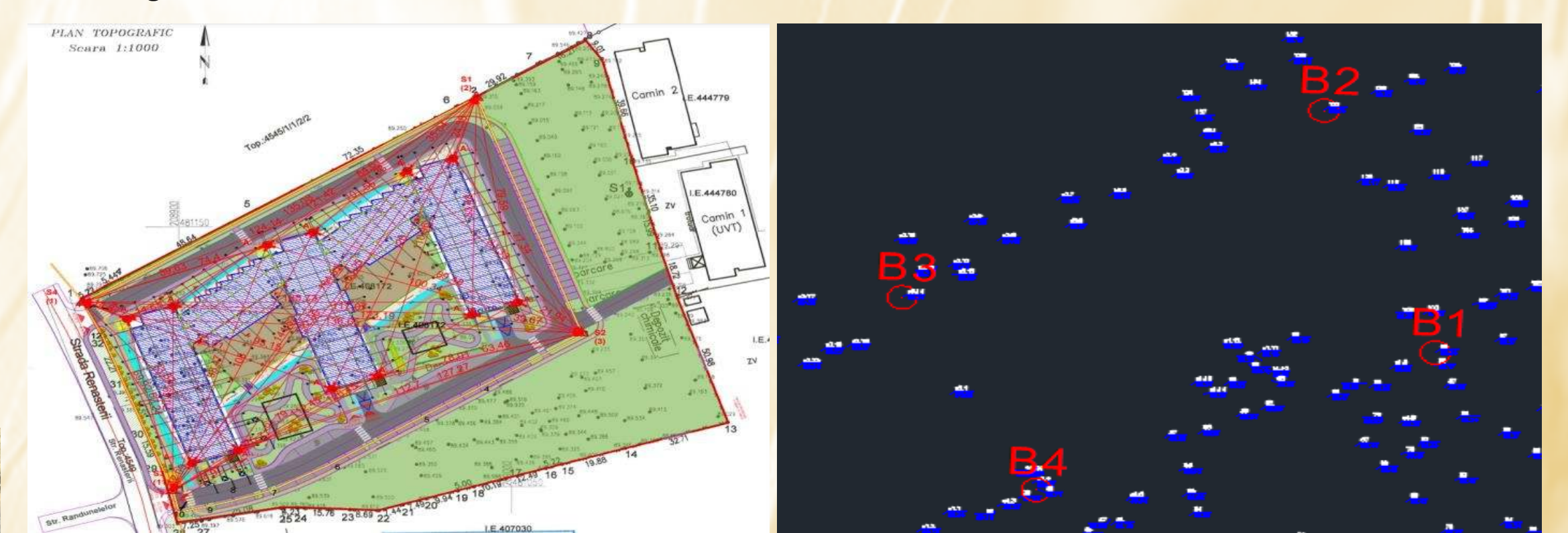


Fig. 3 Topographic measurements overlapped with architect plan Fig. 4 Gns determined points used for creating the geodesic network.

The total station was used for precise point stakeout (Fig. 5) to mark critical locations on the site, such as building corners and connection points for structures. Using Trimble S7 technology, it achieved millimeter-level accuracy, ensuring efficient coordination and preventing deviations in structural assembly.

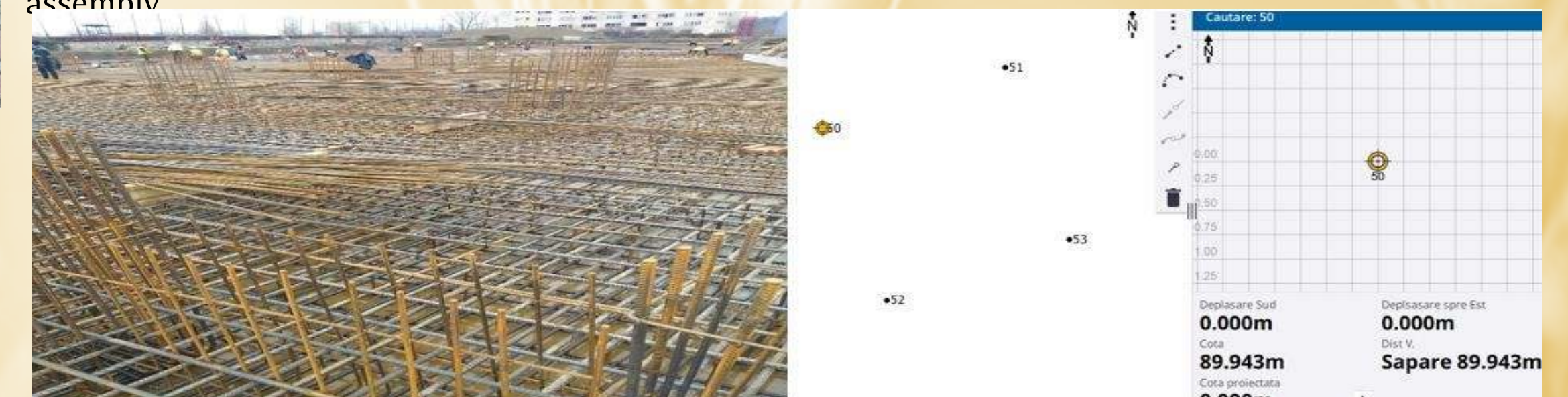


Fig. 5 Point stakeout method to determine pillar corners

The line stakeout method (Fig. 6) was used to mark axes and alignment lines for the building's perimeter and key structural elements. The robotic station provided continuous, precise marking, ensuring accurate positioning of walls, beams, and alignment throughout the construction process.



Fig. 6 Axis stakeout using stakeout line method in order to determine the center of the prefabricated structure

The 3D line stakeout (Fig. 8) with Trimble S7 ensured precise positioning of complex structures, while the Leica Sprinter 250M measured elevations for a leveled raft foundation (Fig. 9). The arc stakeout method, also with the Trimble S7 (Fig. 7), guaranteed accurate alignment of curved elements like



Fig. 7 Stakearc method

Fig. 8 3D Line stake method

Fig. 9 Pouring the leveling concrete after leveling

Modern GNSS systems offer high accuracy and efficiency with real-time corrections (RTK), ideal for complex sites and challenging terrain. Robotic total stations improve stakeout tasks by enabling automated, remote-controlled measurements, reducing human error. Digital levels provide better accuracy and eliminate reading mistakes, speeding up data recording and improving task management.