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CIVIL ENGINEERING AND BUILDING SERVICE TOPOGRAPHIC PERMANENT LANDMARKS NETWORK. SPATIAL COORDINATE OPTIMIZATION

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Abstract: Sustainable development is a modern concept of adaptation conditions for achieving objectives that respond simultaneously to at least three major requirements: economic, social and environmental. Achieving sustainable development cannot be accomplished without a change of mentality of people and without communities able to use resources rationally and efficiently. For an efficient application programs surveying topography discipline the students have imagined and created a network of local topographic permanent terminals required for reporting the rectangular coordinates of applications. In order to obtain more accurate values of these coordinates we have made several types of measurements that will be presented in detail in this work.

The aim of this paper is to optimize the locating terminals coordinates of the points of our faculty, initially determined using GPS technology. Additional measurements were performed in an interval of one year using a total station. Considering that four previously determined terminal network points were placed between the relatively tall buildings, it was decided that it could be better to determine their spatial coordinates using the classical planimetric surveying method. To this end, the coordinates of the two reference points were located and determined near this network with the help of GPS technology in an area with good visibility. In order to determine the coordinates of the two reference points GNSS Permanent Stations National Network was used through the RTK method: RTCM (Radio Technical Commission for Maritime Services). The measurements were using GPS SOUTH S82T, whose field book has the implemented software transcomputation real-time geographic coordinates in STEREO-70 coordinate system. The network of permanent GNSS stations used the fixed station IASI_2.3 and the virtual station RO_MAC_3.1_GG. The solutions for the new determined points were fixed, the

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determination's accuracy ranging between 0.034-0.010 meters. Following these two rounds of measurements of the locating terminals coordinates of the network points of the faculty using GPS technology combined with the classical planimetric surveying method, we got a new set of coordinates with a higher degree of determination accuracy after averaging the results.

Introduction

The purpose of this paper is to determine the position of the landmarks of the Faculty of civil Engineering more accurately using the GPS technology and the classical method. Two series of measurements were made (in two consecutive years) using two different methods, GPS receivers and total station by traditional method. We chose this method of complementary determination because the terminals were placed in the faculty building area and in this area there are relatively tall buildings and dense rich vegetation. This loss of precision determinations using GPS technology can be compensated by using the classic method of determining - the total station. The factors that could influence (in a manner more or less important) the determinations final accuracy of the landmarks spatial coordinates were also highlighted.

Sustainable development is a modern concept of adaptation conditions for achieving objectives that respond simultaneously to at least three major requirements: economic, social and environmental. Achieving sustainable development cannot be accomplished without a change of mentality of people and without communities able to use resources rationally and efficiently. For an efficient application programs surveying topography discipline the students have imagined and created a network of local topographic permanent terminals required for reporting the rectangular coordinates of applications. In order to obtain more accurate values of these coordinates we have made several types of measurements that will be presented in detail in this work.

Setting-up a topographic reference network in order to increase the efficiency of the students classes is a necessity to develop the quality of learning which will substantially contribute to the understanding of the utility of the Surveying discipline which was considered (until recently) less important by all stakeholders in the educational process. Taking into account the signals received from employers who understand the importance of specific knowledge, it is considered to be vital the approaching of the studied cases in order to be near the real problems from the sites where the future engineer is often put in difficulty. This happens because students lack the responsibility of working with the real values of coordinate's points from different applications being almost impossible to verify the final results with values of existing points.

Moreover, topographic points will be used as benchmarks for in-time monitoring of the behavior of the buildings surrounding the Faculty of Civil Engineering and Building Services.

So have been created the premises for the existence of such local networks in our faculty, which is almost non-existent in the universities of our country, as well as modern and sustainable working resources with the possibility to check at any time applications made within a discipline focused mainly on practice engineering in the field of house construction.

1. Material and method

In order to create a reference network of four points arranged in our Faculty's area (Fig. 1), points that were prepared and then placed with the active participation of the students during practical classes.

The landmarks were cast from reinforced concrete and having a truncated pyramid shape with 0.20 m base, 0.15 m small base length and 0.50 m in height. The supports on the ground were performed by using 50 cm long bolts attached with epoxy resin.

Fig. 1. Situation plan with landmarks position

2. Technical consideration

Recognizing the potential of the determination techniques using GPS technology (Navstar, 2001) in order to achieve a modern and precise reference, we considered useful to determine the spatial coordinates of these points with it (Bazlof, Y. A., et al., 1999, Boş N. and Iacobescu O., 2007, Internet_1).

GPS technology is a technology of high performance and high precision depending on the following requirements in the recognition of land phase (Tab. 1).

Tab. 1. Landscape recognition's exigencies

Satellites visibility from the station points	**Absence obstacles absence interference sources**
The reference point's checks	Ground materialization of the points Its stability
Setting-up the logistic devices	Travelling manner Access and travelling time Special equipment (if it is required)

The errors that may occur by using GPS system in order to determine the spatial coordinates of a point are (Johnson, N. L., 1994, Kleusberg, A., 1990, Langley, R. B., 1997):

1. Number and integrity of orbital satellites (functional);
2. Delays in atmospheric layers and signal reflection;
3. Errors due to receiver clock and orbital errors;
4. The number of visible satellites, their position at a certain time and their selective availability (type of information access - free or secure).

It is relevant that the relief, the buildings, the electronic interference or sometimes even vegetation can block signal reception, causing position errors or even total lack of position. After placing the terminals according to the situation we proceeded to determine the spatial coordinates using GPS system with a device type that has a 0.001 ÷ 0.01 m.

The topic of in-time monitoring of the building's displacements must represent an important goal for all engineering structures especially for those of vital importance. Such monitoring, by topographic methods, can detect fissures, subsidence and spatial displacements of engineering structures on time. Measures can prevent disasters such as breakage or loss of structural stability of dams due to the occurrence of uncontrollable events that were not set during the design stage. Monitoring structural displacements (having high precision measurements) will be performed by cyclic measuring the angular and linear values using topo-geodetic methods and instruments.

To calculate the spatial coordinates of the points that make up our faculty network landmarks 2 points determined by GPS technology were used as reference points in the area with good visibility to the satellites (without the adjacent buildings area).

Planimetric surveying is a method for transmitting spatial coordinates of known points to other points of interest in view of their positioning on the field.

Planimetric surveying is a polygonal broken line with the mutual position of the points determined by measuring the distances and angles between the sides of the polygon.

For lifting points network (terminals Building Faculty) will be applied „supported at the ends planimetric surveying" method with known coordinates.

The device used to make planimetry traverse is total station Leica TS 06 with the following specifications:

- angles measuring precision - 2 seconds ;
- distances measuring precision: 1,5 mm + 2ppm;
- measuring range of the distances with a single prism: 3500 m;
- measuring range without prism: 30 m.

Planimetric surveying was made with forced centering and is supported at the ends on points with known coordinates (Fig. 2). In each surveying station, directions were measured by flow method the horizon, in the two position of the telescope. Distances were determined by electronic measurements roundtrip, in the two position of the telescope.

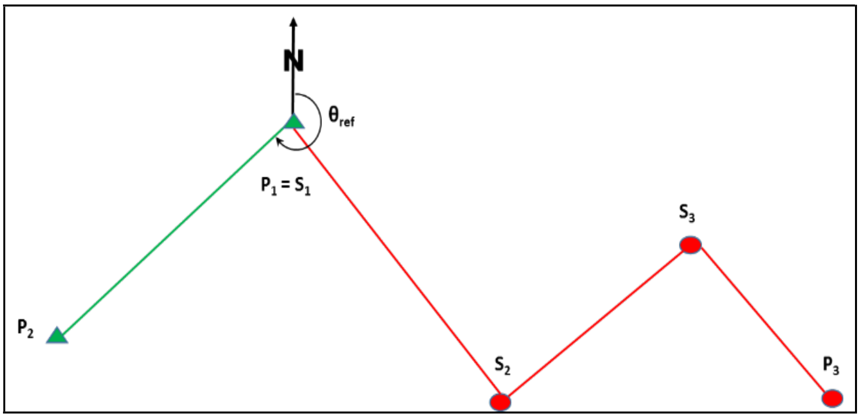

Fig. 2. Planimetric surveying supported on two reference points

3. Description of the topographic assignment

In order to determine the coordinates of the new points GNSS Permanent Stations National Network was used through the RTK method: RTCM (Radio Technical Commission for Maritime Services).

Measurements were performed using two different methods: using a GPS receivers **SOUTH S82T** (Fig. 2 left) and a Total station - **Laica TS 06** (Fig. 3 right).

The GPS receivers whose field book has implemented software transcomputation real-time geographic coordinates obtained in STEREO-70 co-ordinate system. The determinations were made in July 2013 (for the first set) and May 2014.

Fig. 3. GPS SOUTH S82T and Total station - Laica TS 06

From the permanent GNSS stations network, the fixed station IASI_2.3 and the virtual station RO_MAC_3.1_GG were used. Solutions for new measured points were fixed, the determination's accuracy ranging between 0.034-0.010 meters (see Tab. 2).

Tab. 2. Spatial Coordinates of landmarks

Land Mark No.		Spatial Coordinates [m] Receiver – S82T	Spatial Coordinates [m] Total station- Laica TS 06	Average Coordinates [m]
	X	631322.925	631322.876	631322.901
1	Y	696501.349	696501.347	696501.348
	Z	42.2927	42.325	42.309
	X	631330.945	631330.908	631330.927
2	Y	696470.343	696470.37	696470.357
	Z	42.316	42.332	42.324
	X	631339.146	631242.935	631291.041
3	Y	696436.915	696443.643	696440.279
	Z	43.879	44.168	44.024
	X	631291.465	631321.357	631306.411
4	Y	696407.848	696501.406	696454.627
	Z	43.836	44.081	43.959

To determine their coordinates a total station Leica TS 06 was used, and the used method was surveying planimetric supported at one end on the two reference points (P_1 with their spatial coordinate X_1= 631286.226, Y_1= 696523.630, Z_1= 42.089 and P_2 with their spatial coordinate X_2= 631357.137, Y_2= 696725.604, Z_2= 41.406 – Fig.3) determined using GPS technology.

Thus, starting from two reference points the device was placed in S_2 station and performed measurements to landmark B_1 and B_2 and the station made measurements for the points S_3, B_3, and B_4. For verification, we determined again the S_3 station spatial coordinates of the landmark B_1. We chose this route because of the existing vegetation in the area of measuring and there was not possible to observe all stations (Fig. 4).

Downloading data processing and compensation data was done using the Toposys 4.4 software. Also sides hot and data processing was performed with the same program and the reporting points was made with AutoCAD. Calculation of coordinates of radiated points station was made in projection system Stereo'70. These results are presented in Tab. 2.

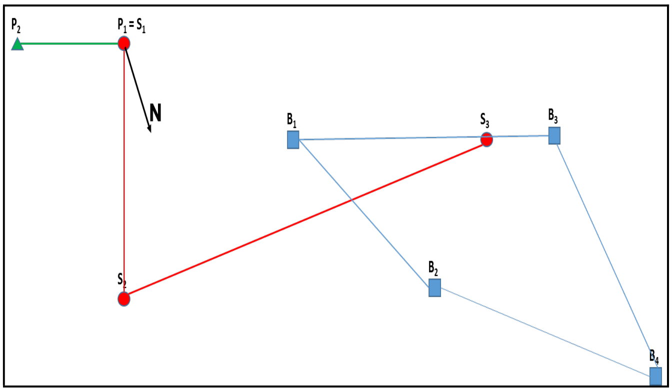

Fig. 4. Outline supported planimetric surveying

After this series of measurements with those obtained by averaging their initial GPS technology we obtained and improved accuracy for determining the spatial coordinates of our faculty landmarks. The results are found also in Tab. 2.

Conclusions

In this paper we determined the position of the landmarks of the building faculty using two modern methods. First, they were determined using GPS technology which ensures a better accuracy for plane coordinates and less good for shares. For the second measurement, we combined the accuracy of GPS technology with the classic method of spatial surveying. We used this combination of methods because the points were located between buildings and a determination with GPS technology did not provide a good enough accuracy due to errors occurring. For spatial surveying we chose the support points to be determined with the help of GPS technology because we were in an area with good visibility to satellites.

Thus, combining the two methods, we determined the spatial coordinates of these points more accurately.

In perspective we intend to do a planimetric surveying coordinates determination by making a reference to two reference points and inventory of existing national geodetic network which are near found.

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