Co-funded by the
Erasmus+ Programme
of the European Union

SAMARKAND STATE ARCHIRECTURAL AND CIVIL ENGINEERING INSTITUTE NAMED AFTER M. ULUGBEK

Department of Geodesy and Cartography

Online internship

REPORT

at Budapest University of Technology and Economics in the frame of the Erasmus+ DSinGIS project

(February 14– April 14, 2021)

Participant: Malika Aminjanova

Scientific supervisor: Dr. Lóránt Földváry

SAMARKAND – 2021

Content

Introduction

DSinGIS is an Erasmus - + CBHE project and knowledge exchange platform for teachers, doctoral students and managers who want to gain knowledge. To increase their competences, knowledge and skills, the project provides opportunities.

The goal of the DSinGIS Erasmus - + project is to support Uzbekistan in sustainable development through the contribution to Geoinformation Sciences (GIS), to identify the missing puzzle in the Uzbek education system after completing the Master of Science level by establishing a Doctoral School for delivering specialists with PhD degree for the Uzbek society. (http://www.dsingis.eu/background/).

The objectives of the DSinGIS project are: to develop a new doctoral program, innovative doctoral courses and methodologies that support the continuous professional development of applications in geoinformatics, to create a modern educational and research environment based on ICT, to strengthen links between higher education institutions (HEIs) and academic research institutes (AI), to increase the scientific level of academic and research personnel in partner universities of Uzbekistan, to orient Uzbek scientists to interdisciplinary geoinformation science in the field of geospatial doctoral research, improve the engagement of Uzbekistan's academic staff and doctoral students, strengthening the internationalization of universities / AI, research capacity: research laboratories and the joint Research Center for Interdisciplinary Applications in Uzbekistan, annual GI conferences aimed at multi-purpose effects (http://www.dsingis.eu/aims-objectives/http://www.dsingis.eu/3rd-call-for-applications/).

DSinGIS has implemented an online learning infrastructure as a common platform for young teachers, doctoral students, including supervisors. For supporting the PhD studies, grants for Uzbek potential PhD students is provided during the project period, which has provided the supervision background of the present research. I am, Aminjanova Malika Bahtiyorovna, a lecturer at the Samarkand Institute of Architecture and Civil Engineering under the guidance of Dr. Lóránt Földváry from the Budapest University of Technology and Economics, has completed this online internship as a grant holder received in the frame of the 3rd call of applications (http://www.dsingis.eu/3rd-call-for-applications/). My research work consisted of an analysis of vertical deformation based on repeated measurements of the Family Park shopping center in the city of Samarkand, Republic of Uzbekistan.

Purpose

A significant place in the modern practice of engineering works is occupied by the observation of deformations of buildings and structures. No construction is complete without measuring deformations, and in the construction of larger structures, observations can continue throughout the entire period of operation, since the magnitude of deformations depends on the stability and normal mode of the technological process. But at the same time, the complexity and number of observations, as well as the requirements for the accuracy of their production, may increase annually (Astakhova, 2009).

Due to the design features, natural conditions and human activity, structures as a whole and their individual elements experience various types of deformations. In general, the term "deformation" refers to a change in the shape of the object of observation. In geodetic practice, it is common to consider deformation as a change in the position of an object relative to the original one (Wieser and Capra, 2017).

In the framework of this study, the vertical deformation of the building of the shopping and entertainment center "Family Park" was analyzed. The building is located in the western part of Samarkand, three-storey, with parking lot on the underground floor. The building is a public place for recreation and entertainment of people. It can accommodate a large number of people at the same time. The peculiarity of this building is that the distance between the supporting columns is more than 10 meters. Therefore, monitoring the deformations of the building during construction was necessary, and to determine when it settled and has stopped sinking, in order to increase the level of safety of the building by reducing the probability of structural hazards.

Time table

My online internship in the DSinGIS project took place from February 14 to April 14, 2021. A detailed training plan for 2 months was drawn up with the supervisor Dr. Lóránt Földváry:

1. Online meeting via the ZOOM platform with the supervisor Dr. Lóránt Földváry: discussion of the training plan, schedule, goals and training strategy.
2. Selection of topics and objects for research. Approval and discussion of the topic and object of research with the supervisor.
3. Data collection. Selection and study of literary and electronic sources related to my research.
4. Performing calculations and learning effective ways to process data. Introduction and data processing using Excel and AutoCAD programs.
5. Writing a scientific article based on the results of research and calculations performed.
6. Registration and submission of the article to the international conference GISCA 2021.

The preparation process

As part of my online internship, a step-by-step, technological, scientific analysis was conducted on the topic of a scientific paper devoted to the analysis of vertical deformation based on repeated measurements of a shopping center building.

The preparatory process consisted of discussing and choosing the research topic of an online internship with Dr. Lóránt Földváry, collecting data from the construction site, preparing data (uploading and formatting them using Excel and AutoCAD programs), studying material about the geometric alignment method and the least squares method.

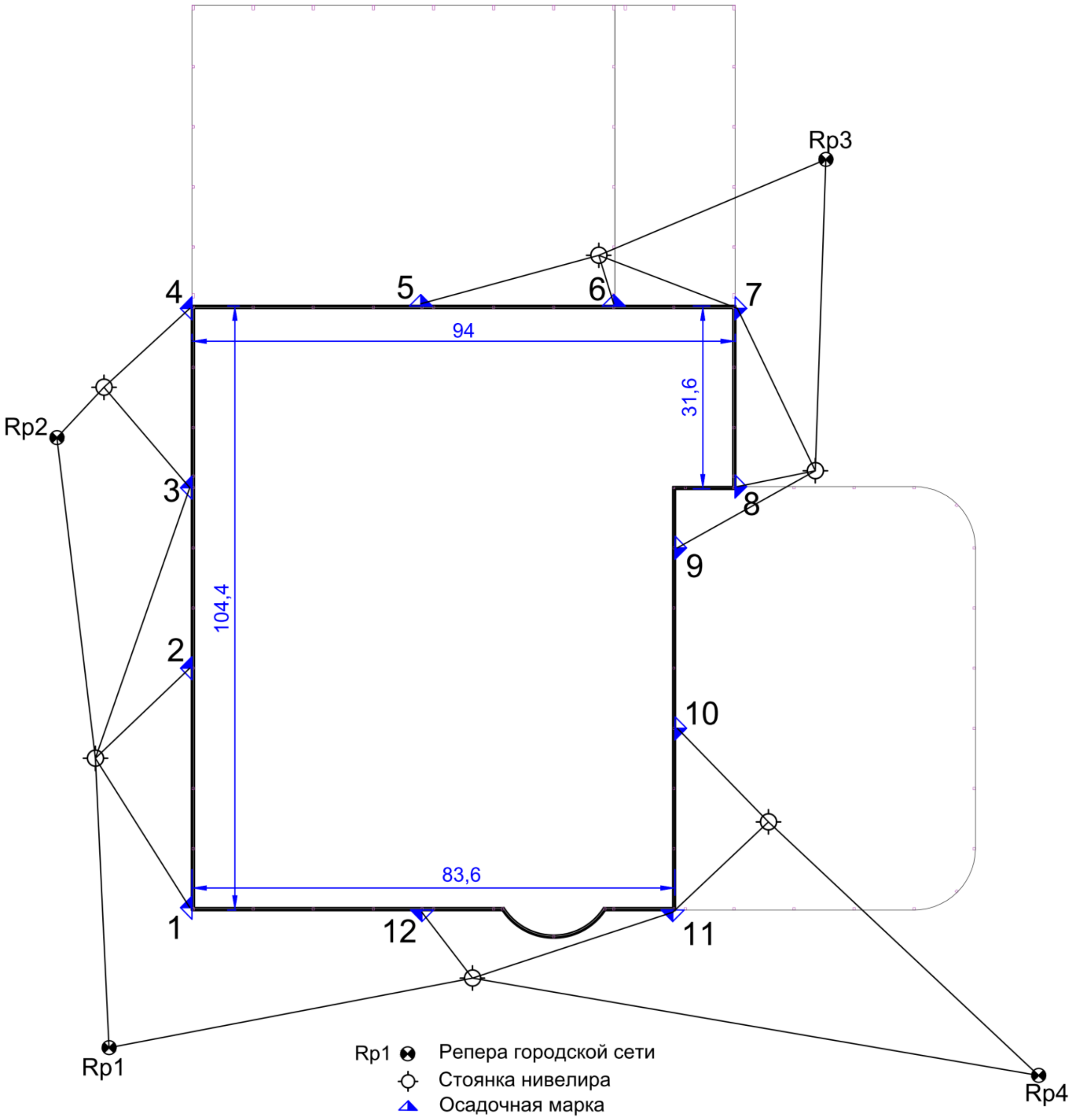


Figure 1. The surveying plan of the building with the location of the vertical reference point (Rp1 to Rp4), the stations of the instruments (6

unlabelled points) and the test points (benchmarks) on the wall of the building (1 to 12).

Activities

The first action was to re-measure the vertical deformation of the building. However, it was found that the measurement accuracy is in the range of ±1-3 mm, so the result of building subsidence is completely insignificant.

Table 1. Subsidence of the test points determined with respect to the null epoch (Oct. 2018). Unit: mm

№ points	Mar.2019	Jul.2019	Nov.2019	Mar.2020	Jul.2020	Nov.2020	Mar.2021
1	-9	-12	-15	-16	-16	-16	-16
2	-5	-8	-11	-14	-15	-16	-16
3	-4	-7	-10	-12	-14	-14	-15
4	-7	-12	-15	-17	-20	-20	-20
5	-5	-8	-10	-13	-15	-15	-15
6	-3	-7	-9	-11	-14	-14	-14
7	-6	-10	-13	-15	-17	-17	-18
8	-4	-8	-11	-15	-18	-18	-18
9	-2	-5	-8	-11	-15	-15	-15
10	-5	-9	-12	-14	-15	-15	-16
11	-8	-13	-15	-18	-20	-20	-20
12	-4	-7	-10	-13	-14	-14	-15

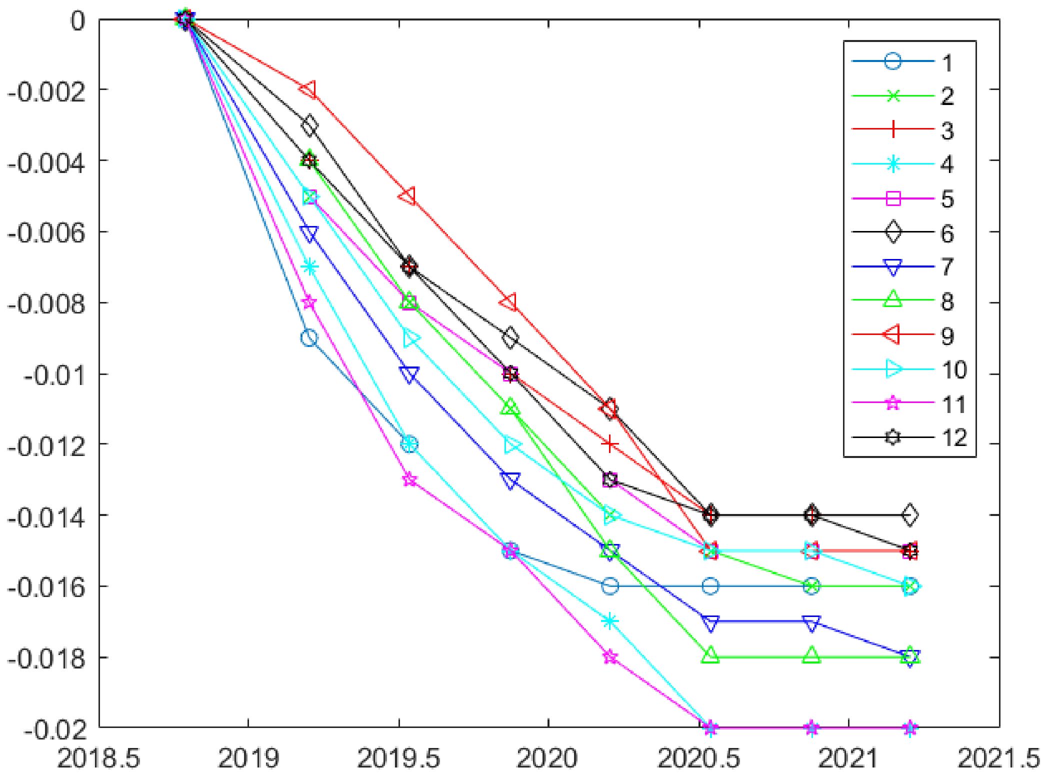


Figure 2. Subsidence of the test points determined with respect to the null epoch (Oct. 2018). Unit: mm

Then I made a series of calculations to predict future deformations. To do this, an exponential curve was constructed on a time series of height values at each point using the least squares method and the coefficients of the function were estimated, and the rate of change in height (the rate of subsidence) was obtained analytically. Using the calculated velocity values obtained, I obtained the future values of subsidence. As a result, probable deformations were determined between the last measurement epoch (March 2021) and the end of 2022 (December 2022).

Table 2. Parameters (coefficients, accuracy estimates) of LSM fit to height variations, and the observed (March, 2018 to March, 2021) and predicted (March, 2021 to December, 2022) subsidence.

№ points	a	b	c	R^2	RMS [mm]	ab	$\Delta h_{observed}$ [mm]	$\Delta h_{predicted}$ [mm]
1	0.0754	-1.9190	191.5835	0.9949	0.48	-0.1448	-16	-0.2
2	0.0353	-0.7539	191.5805	0.9886	0.74	-0.0266	-16	-2.3
3	0.0331	-0.6793	191.5810	0.9924	0.56	-0.0225	-15	-2.6
4	0.0503	-1.0089	191.5776	0.9924	0.75	-0.0508	-20	-1.7
5	0.0339	-0.7863	191.5818	0.9858	0.78	-0.0267	-15	-2.1
6	0.0323	-0.6230	191.5807	0.9801	0.89	-0.0201	-14	-2.9
7	0.0427	-0.9285	191.5797	0.9968	0.42	-0.0396	-18	-1.8
8	0.0419	-0.5746	191.5741	0.9769	1.25	-0.0241	-18	-4.3
9	0.0406	-0.3184	191.5692	0.9627	1.39	-0.0130	-15	-6.3
10	0.0395	-1.0007	191.5824	0.9916	0.62	-0.0395	-16	-1.3
11	0.0547	-1.1656	191.5783	0.9939	0.66	-0.0637	-20	-1.1
12	0.0364	-0.9213	191.5832	0.9820	0.87	-0.0336	-15	-1.5

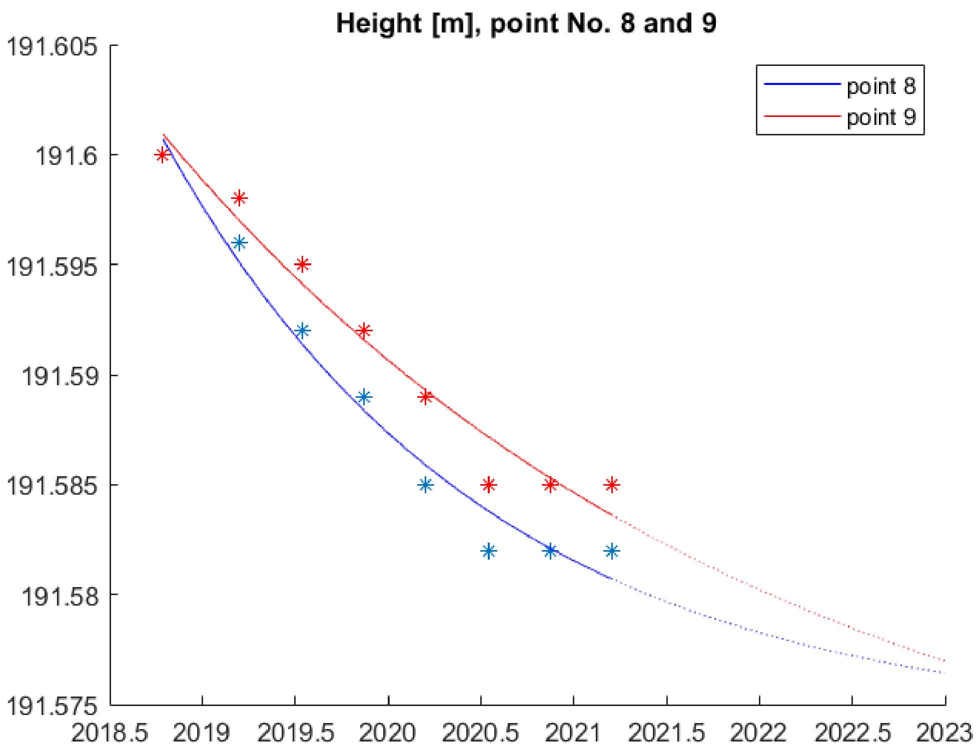


Figure 3. Time series of heights of points 8 and 9, result of the fitted exponential curve and the prediction

The next stage of the study was to assess the slope, as can be seen in Figure 4, the subsidence on the sides of the building is not uniform, which can lead to structural deformations.

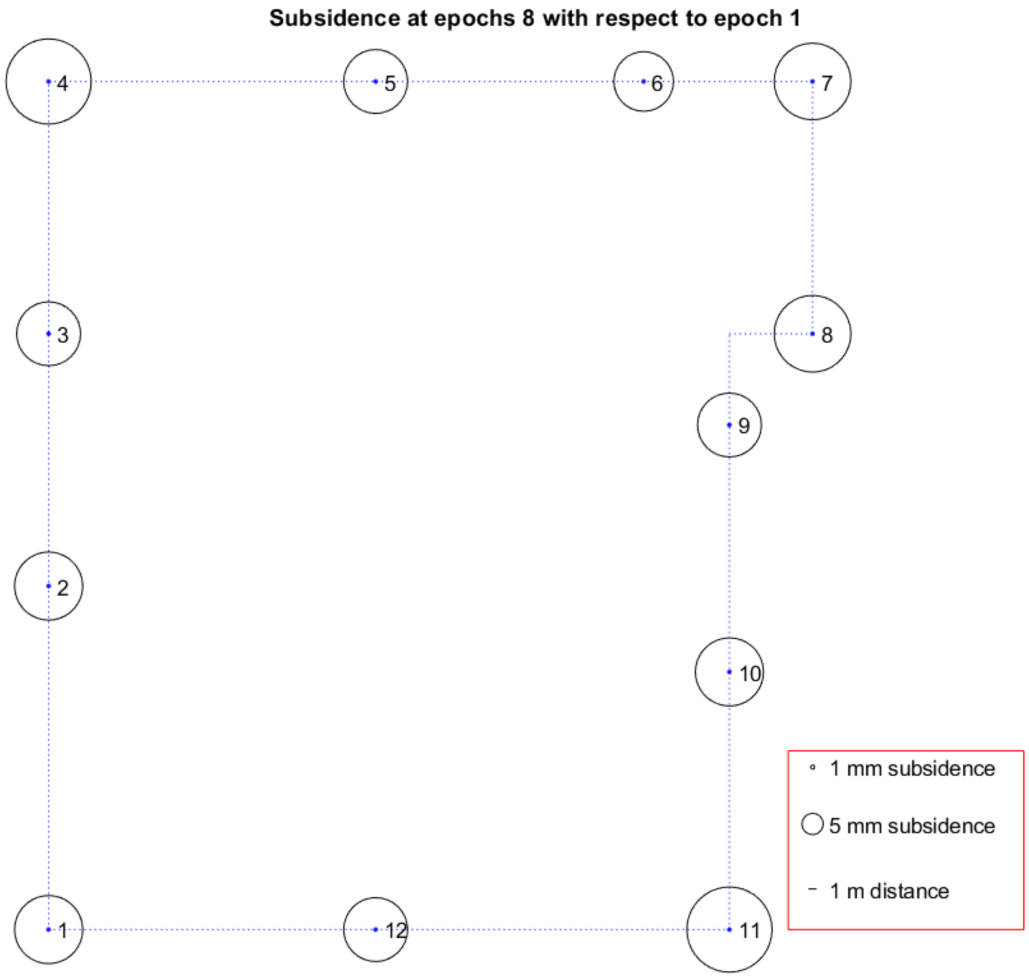


Figure 4. Subsidence of test points of the building at the last measurement campaign with respect to the null measurement. The scale of the figure and of the displayed deformations are different; the magnitudes are defined in the legend.

According to (Fig. 5), the slope of the sides was reached gradually over time, so I analyzed only the last measured epoch.

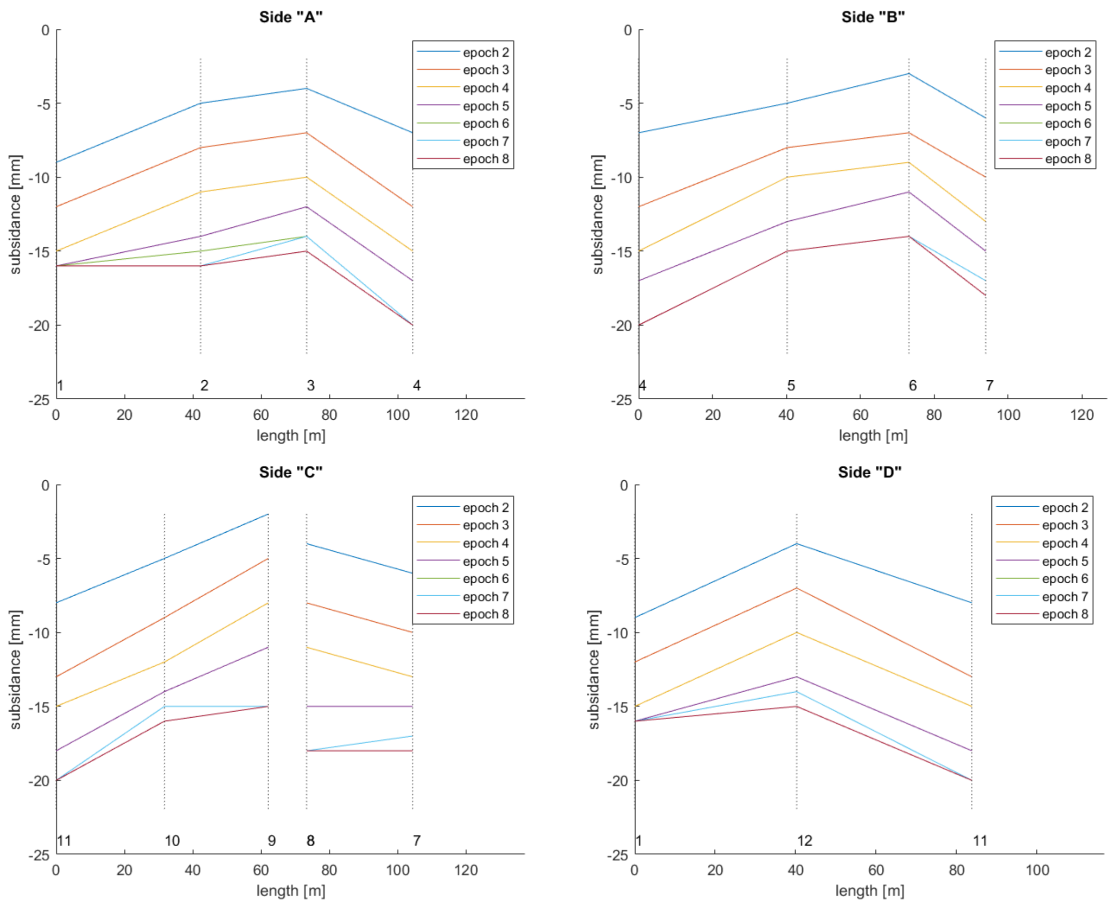


Figure 5. Subsidence of the building sides by time.

As a result of the work, the calculated height differences were established, which are -3.1 mm (point 4), +2.8 mm (point 7), -0.5 mm (point 8), +5.0 mm (in the concave corner between points 8 and 9) and -4.1 mm (point 11). When the values of the subsidence are cumulatively summed along different sides, the closing error becomes 0.1 mm, which is surprisingly small given the roughness of the estimation method. Cumulative summation results in a settling model with values relative to test point 1. The relative subsidence values are -3.1 mm (point 4), -0.3 mm (point 7), -0.3 mm (point 8), -0.8 mm (at the concave corner between points 8 and 9), and 4.3 mm (point 11). The relative subsidence model is shown in Fig.6. Based on this drawing, there is an obvious slope in the direction of the lines of points 4 and 11, roughly perpendicular to the axis passing through points 1 and 7. Given the size of the building (see Fig. 1), the slope is estimated at 0.06% (7.4 mm along the 133.9 m line).

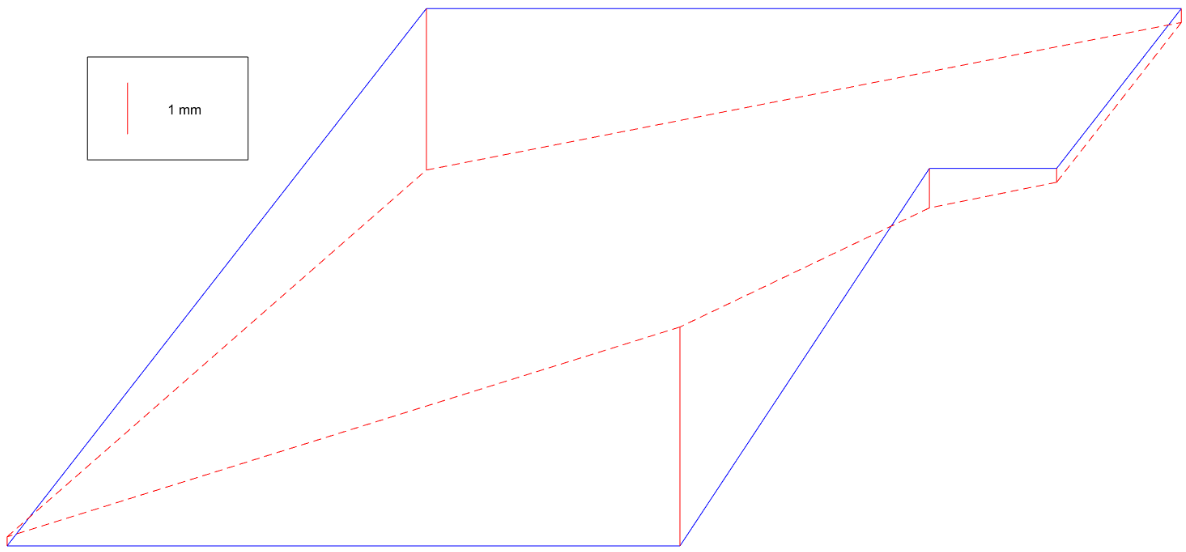


Figure 6. The relative subsidence model. The blue line indicates the floor plan in a tilted view, and the relative subsidence is red. The direction of the relative subsidence (up or down) at the test points indicates the sign.

Based on the above, it was concluded that the slope of the building is unidirectional, so no deformation of the structure can be expected because of this.

Results

The present research has been supported and conducted within the frame of the Erasmus+ CBHE Key Action 2 project titled DSinGIS.

All the scientific data obtained during the research during the internship were used as the basis for a scientific article that I sent to the international online conference GISCA2021 within the framework of the DSinGIS project, which was held from May 31 to June 2, 2021.

Acknowledgments

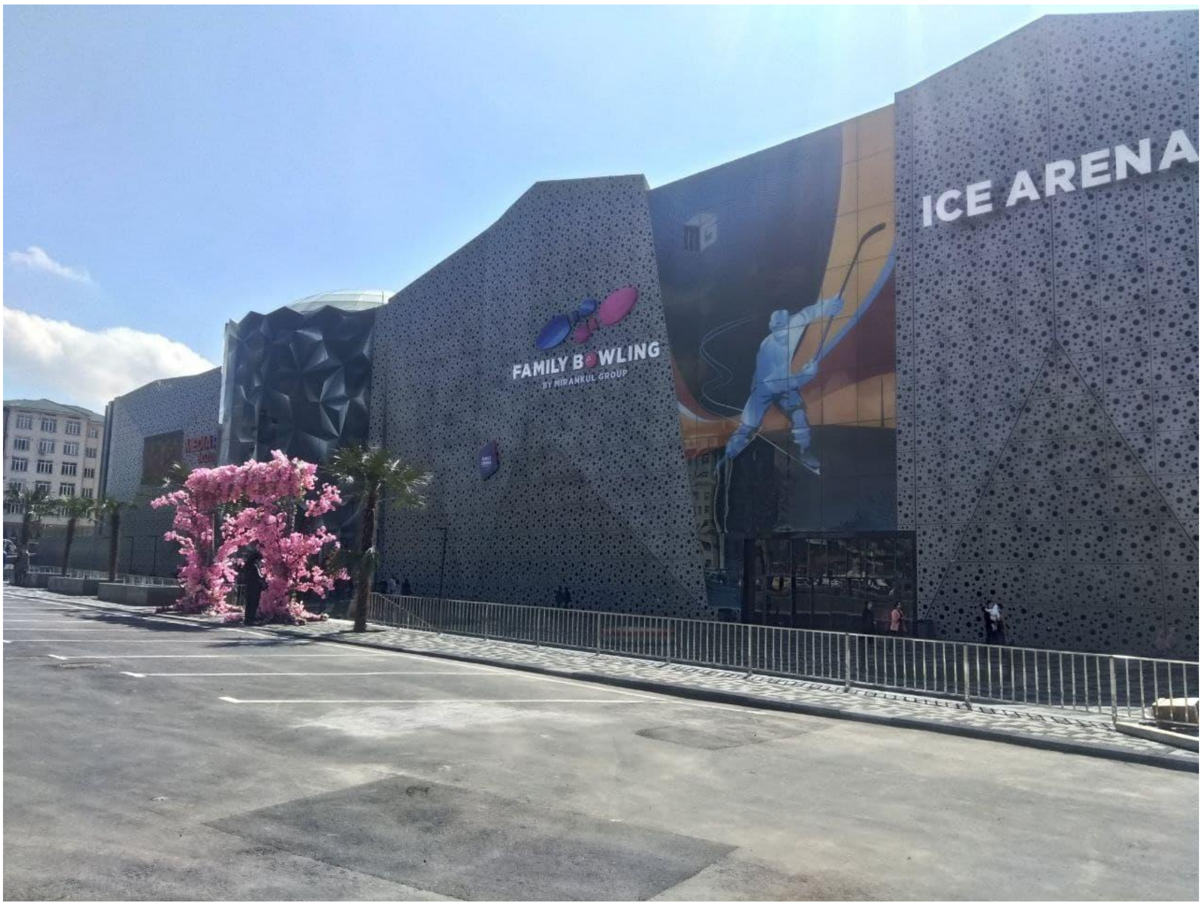
I would like to express my deep gratitude to Erkin Hujayarovich Isakov, the regional coordinator of the DSinGIS project, Ilkhom Isakovich Abdurakhmanov, the national coordinator of the DSinGIS project in Uzbekistan, and my scientific supervisor Dr. Lóránt Földváry for the opportunity to participate in this online DSinGIS project.

I sincerely thank and express my deepest respect to Dr. Lóránt Földváry for his loyalty and patience, interest and responsiveness, advice and support. From the choice of the topic to the final completion of the work, he always gave me valuable advice. My supervisor's serious scientific approach and rigorous mastery of science deeply infected and encouraged me to continue working in this direction.

Photos of the shopping center

Photos from the construction site of the Family Park shopping center

Family Park shopping center after opening



References

http://www.dsingis.eu/3rd-call-for-applications/

Astakhova, I. A., 2009, Geodesy, educational and methodical manual. Federal Agency for Education, GOU VPO, Maikop State Technological University, Faculty of Agricultural Technologies, Department of Land Management. Maykop; link: http://1igp.ru/info/rol-geodezii.php, last retrieved 04.05.2021

Wieser, A., Capra, A., 2017, Special Issue: Deformation Monitoring. Applied Geomatic, Vol. 9, No. 2, 79-80; doi.org/10.1007/s12518-017-0192-0

Eteje, S.O., Ono, M.N., Oduyebo, O.F., 2018, Monitoring and Analysis of Vertical and Horizontal Deformations of a Large Structure Using Conventional Geodetic Techniques. Journal of Environment and Earth Science, Vol. 8, No. 12, 52-61.

Gura, T.A., Biryukova, A.O., Ovsienko, E.A., 2016, Deformations of buildings and structures and the procedure for their detection (in Russian). Molodoj učenyj ISSN 2072-0297, No 30 (134), 59-62.

Kuang, S., 1966, Geodetic networks analysis and optimal design concepts and applications, (Chelsea, Michigan: Ann Arbor Press. Inc.)

McCarthy, D. F., 2006, Essentials of Soil Mechanics and Foundations Basic Geotechnics (7th Edition). U.S.A: Prentice Hall; ISBN-13: 978-0131145603

Peng, X., Zhang, Z.B., Wang, L.L., Gan, L., 2012: Does soil compaction change soil shrinkage behaviour? Soil and Tillage Research, Vol. 125, 89-95; DOI https://doi.org/10.1016/j.still.2012.04.001.

Singh, R.; Setan, H., 2001, Deformation analysis of a geodetic monitoring network. Geomatica, Vol. 55, No. 3, 333–346.

http://www.dsingis.eu/dsingis-project-became-the-winner-in-the-fair-of-erasmus-info-day/

https://www.afisha.uz/gorod/2021/03/29/family-park/