SCEgeo CONFERENCE
28th Conference - SURVEYING, CIVIL ENGINEERING, GEOINFORMATION IN SUSTAINABLE DEVELOPMENT
June 2-10, 2020 - Bydgoszcz, Poland

Analysis of object cracks dilation caused by thermal changes

Jacek Sztubecki [1)], Szymon Topoliński[1)], Maria Mrówczyńska [2)], Baki Bağrıaçık[3)] , Ahmet Beycioğlu[4)]
[1)] UTP University of Science and Technology in Bydgoszcz, Poland, email: jaceksz@utp.edu.pl; szymont@utp.edu.pl
[2)]University of Zielona Góra, email: m.mrowczynska@ib.uz.zgora.pl [3)]Çukurova University, Adana, Turkey, email: bbagriacik@cu.edu.tr
[4)] Adana Alparslan Türkeş Science and Technology University, Adana, Turkey, email: abeycioglu@atu.edu.tr

INTRODUCTION

Correctly performed measurements, together with the correct interpretation of results, allow us to obtain reliable information on building movements. Based on correctly selected methods, they allow us to determine the dynamics of object displacement and deformation. Current systems for monitoring and diagnosing the condition of buildings allow, depending on the size of the object, to determine the object's geometry in full (laser scanning) and examine the behavior of its structural elements. It is essential to choose research methods to define factors that affect the geometry of the object. Correct diagnostics of the technical condition of the building defining the factors causing negative changes of the object to allow to minimize them, determine how the building will behave in the future, estimate how much it will cost to modernize it, and plan its further safe use. The article shows the use of two separate measurement methods to identify factors affecting the deteriorating condition of the object. An analysis was made of the changes in crack widths created at the research facility (above-ground passage of the main buildings of the UTP in Bydgoszcz). The method used in the study is based on the SHM X crackmeter from SHM. Simultaneously, the geometry of the connector was observed using the geodetic method of determining displacements, establishing a measurement, and control network on the object. This method uses the Leica TDRA 6000 total station. The combination of these technologies has allowed the definition of the factors causing the formation of scratches. Such solutions can be successfully used in monitoring deformations and displacements of both small and larger objects.

RESEARCH METHOD

After eighteen years of use, scratches and cracks were noted on the walls and floor of this structure. They indicate the presence of deformation in its structure. The scratches were examined on an object located on the UTP campus in Bydgoszcz. It was built in 2001 and has since served as an above-ground passage connecting University buildings. The outside and shape of the structure are shown in Figure 1.

Fig. 1. The outside and shape of investigated object

Deformations that cause scratches may have been associated with the foundation of the object because it was found that there were expansive soils under the test object. The geotechnical cross-section showing the subsoil under the investigated object is shown in Figure 2.

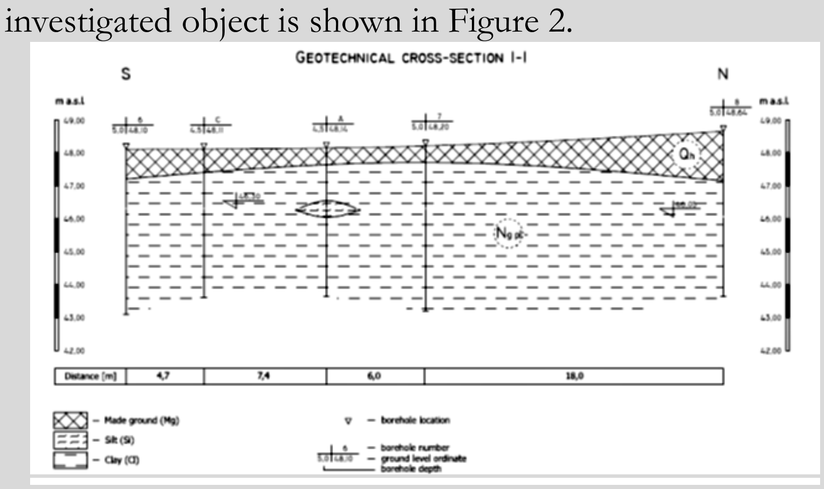

Fig. 2. Geotechnical cross-section under the investigated object

Expansive soil is especially susceptible to changes in humidity. This property should also be considered when determining displacements and deformations.

During the comprehensive investigations of the object, this feature was eliminated as conditioning the occurrence of any changes in its geometry.

As part of the investigations in the places of structure cracks, the SHM X crackmeter was used to measure the crack width. At the same time, geodetic measurements of the displacement and control network were made. Measurements using the TDRA6000 laser station with instrumentation allowed us to obtain submillimeter accuracy of determining point displacements. The network-controlled points were also placed in places where the crack opening was directly observed. This gave the opportunity to observe the displacements of the scratches in a uniform spatial coordinate system. The results of opening the scratches obtained from both methods were also compared. Figure 3 shows the location of the measuring network of two methods (pins and washers) next to the resulting cracks.

Fig. 3. The location of the measuring network of two methods next to the resulting cracks

Construction monitoring covered three seasons. During this time, 35 series of measurements of crack openings were made in relation to pins and four series of geodetic measurements. Detailed analysis of the results will be presented in the article.

CONCLUSIONS

The research presented in the article is an extension of the existing ones, in which several factors that could have a destructive effect on the structure were excluded. The analysis of the test results compiled from both methods showed a significant impact of thermal changes on this type of structure. It also confirmed the thesis about the benefits of conducting research using several methods simultaneously. It is worth noting that regardless of the results and their interpretation, it should be remembered that in the case of continuous or periodic monitoring of displacements, the choice of measurement method and data processing methods depends on the nature of the object and specific environmental conditions. Qualitative and quantitative analyzes of displacement measurement data presented in this study confirm that the methods used to obtain information, and the calculation procedure used were adequate.

Summary: The article presents the synthesis of the results of structure tests carried out using two measurement methods: crackmeter SHM X and geodetic method for determining displacements. As part of the research, measurements of the measuring and control networks were carried out. The research used TDRA6000 laser station measurement technology, which together with the applied calculation scheme showed submillimeter accuracy of determining 3D displacements of controlled points. The control points were also placed in places where the gap opening was directly observed. This gave the opportunity to compare the obtuse results with those obtained from a crackmeter. The use of these methods in parallel gives a more complete picture of the changes taking place in the places of construction, where under the influence of stresses there are signs of destruction. The object adopted in the research connects the buildings of the UTP University of Science and Technology in Bydgoszcz. Due to its function it is a heavily exploited object. Objects of this type require the necessity to perform periodic tests of their stability. Interpretation of test results and identification of possible hazardous conditions that may indicate the danger of a construction accident is extremely important.

Keywords: a technical structure condition, geodetic displacement measurements, building structure failures, cracks

„This article/material has been supported by the Polish National Agency for Academic Exchange under Grant No. PPI/APM/2019/1/00003”