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GEOMETRIC INTERPRETATION OF THE RESULTS OF THE MEASUREMENTS OF ENGINEERING STRUCTURES

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Abstract. In this paper, examples of graphic presentations of performed measurement results have been presented. These results concern vertical and horizontal dislocations and deformations of given objects. The monitored objects were two churches, both situated near a very busy street, and a hall of a newly built building. One church was about 80 years old and the other 100 years old. The visualization of the findings, mainly presented in the 3D technique, is of great importance for interpretation of the change geometry of the objects in time and finding the causes of their dislocations and deformations.

Keywords: visualization, geometric interpretation, geodetic measurements of displacements

1 Introduction

Monitoring of engineering structures has been one of the most important tasks of geodesy. Such a survey is usually carried out in order to test the building in terms of safety regulations and its structure design calculations and also to contribute to the development of the theory itself.

The methods used for gaining information have a great influence on its reliability and they provide possibilities of gaining expert information. In a cause-effect interpretation the way of the results presentation should provide some feedback on the basis of which, an appropriate decision could be taken.

One of geodetic methods for presentation of measurement results is the graphic one which makes geometric interpretation possible. The procedures enabling visualization of spatial information in the 2D and 3D techniques are of great importance for evaluation of such geodetic phenomena as displacements and deformation of engineering objects and devices. The 3D projections which depict deformations well are considered to be a reliable source of information. Furthermore, such a presentation of an object gives us the possibility of investigating a particular structure, showing its all parts and sides by changing the picture points of view. In such cases, the possibility of faster and easier interpretation of results can not be underestimated [1]. The article deals with examples of presentations of geodetic measurement results for engineering objects displacements.

2 Examples of visualization

Example 1.

The analyzed object is a brick church which was built between 1933-1939, and according to the measurements, its size is 48.2 x 21.9 m. The building started to be observed approximately after 50 years of its exploitation, that is, when the first visible cracks, horizontal displacements and deflections were noticed. Both the church structure and its

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vicinity were being carefully monitored and geodetic measurements were involved in the research. Each time the results obtained in the research were further subjected to explicit mathematical and geometric analysis, including an analysis of changes occurring in the closest environment and the foundation. Visualization of the object displacement and deformation had a considerable influence on the interpretation of the results. To illustrate it, Figure 1 presents the object displacement and deformation. The graphics shows the object deformations which occurred within the period of 8 years. Figure 2 presents the annex wall deviations from the vertical plane.

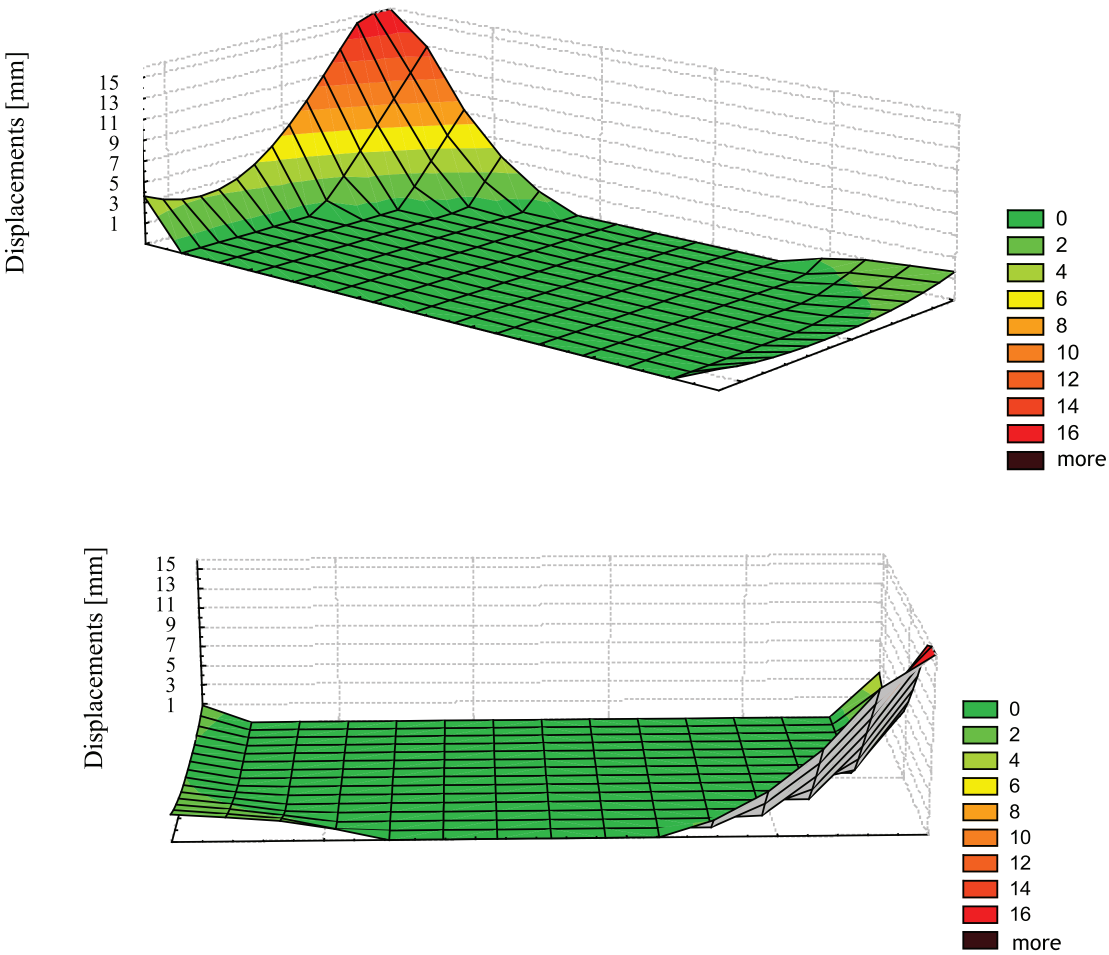

Figure 1. Deformations of the object during 8 years (from two different observation points)

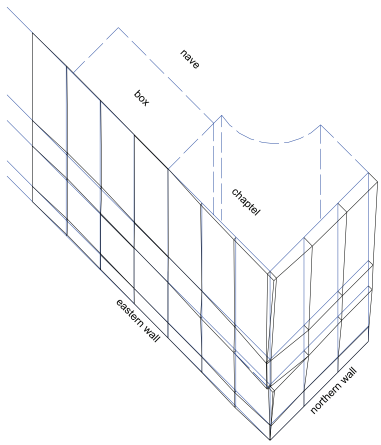

Figure 2. The annex wall deflection in relation to the vertical plane

Example 2.

Investigations of the second church structure included a survey of the church floor in the nave (20,52 x 29,40 m). After having marked the areas of measurement, the points were leveled according to the accepted scheme and the deviations from the vertical plane crossing the point of the highest spot elevation were established.

Figure 3 depicts deformations of the surveyed church floor, that had probably been formed within a period of a century. In order to present deviations in a more distinctive way, two different ways of projection were offered.

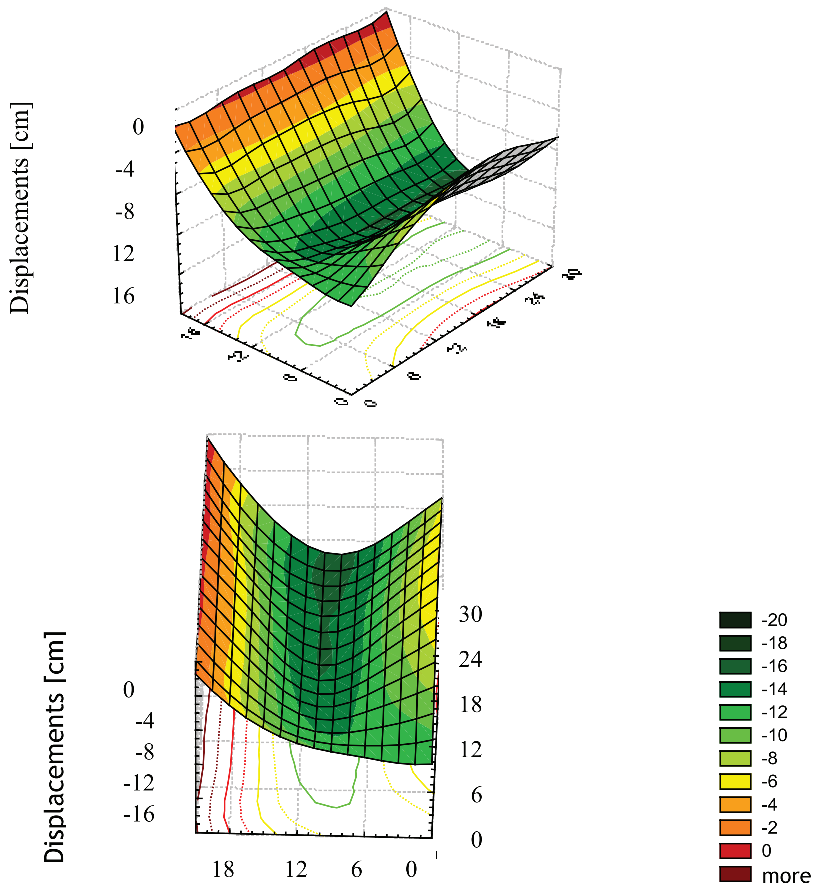

Figure 3. Distortion of the floor plane in 2D and 3D

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The floor plane was inscribed into the examined system of points by means of the smallest squares, and presented in Figure 4.

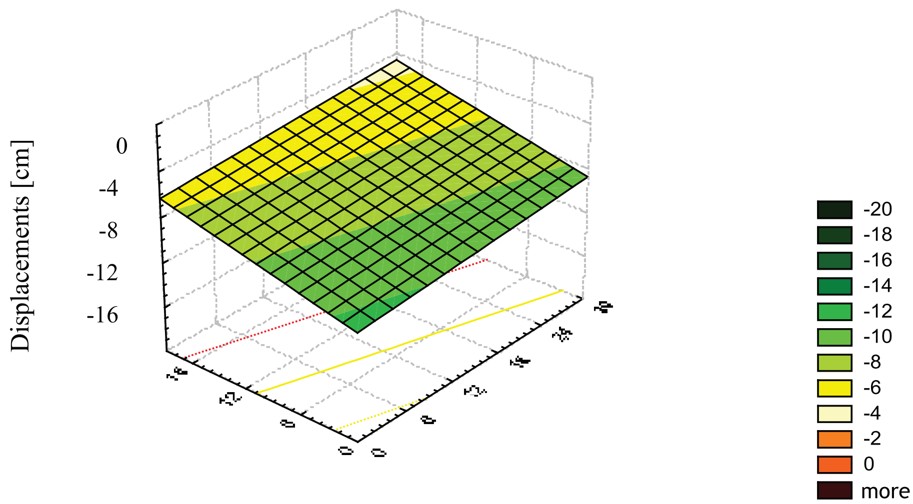

Figure 4. Plane after the approximation process plane in 2D and 3D

As it can be seen in the figure, plane 4 is evidently battered in one direction (toward the busy street). Taking into consideration that the church floor battered we may come to a conclusion that the structure of the whole building is likely to deviate from the vertical as well.

It should be emphasized that the building was erected about 100 years ago, when the problem of traffic intensity simply did not exist.

Example 3.

Check measurements of the floor (24,0 x 48,0 m) were carried out in a production hall, right after it had been manufactured. The standard leveling method was applied and the deviations with reference to the point with the highest spot elevation were determined. Deviations from the horizontal plane have been shown in Figure 5.

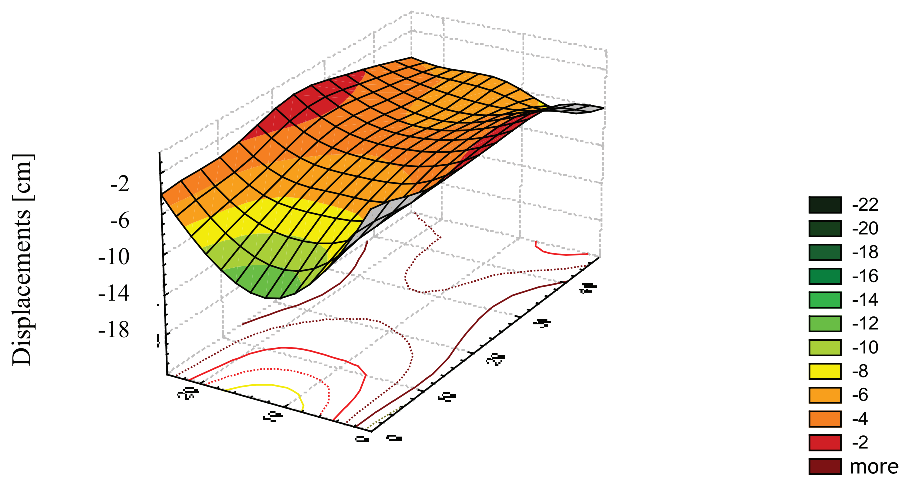

Figure 5. Deviations of the floor from the horizontal plane in 2D and 3D

The next check measurement of the floor was conducted after five years and it involved the same method and covered the same areas. Deviations from the horizontal plane in relation of the point spot elevation, which was highest in the previous measurement, has been shown in Figure 6.

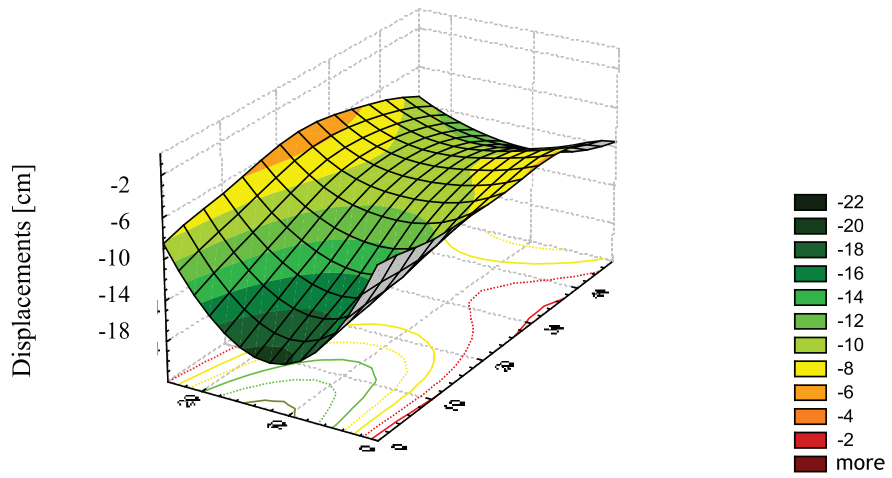

Figure 6. Deviations of the floor from the horizontal plane in 2D and 3D (after 5 years)

On the basis of a current and zero-like measurement displacements of points which occurred during the period of five years were established. The obtained differences of spot elevations show the floor deformation caused by the negative influence of geological changes, the foundation conditions and the way it was used . Figure 7 depicts these deformations.

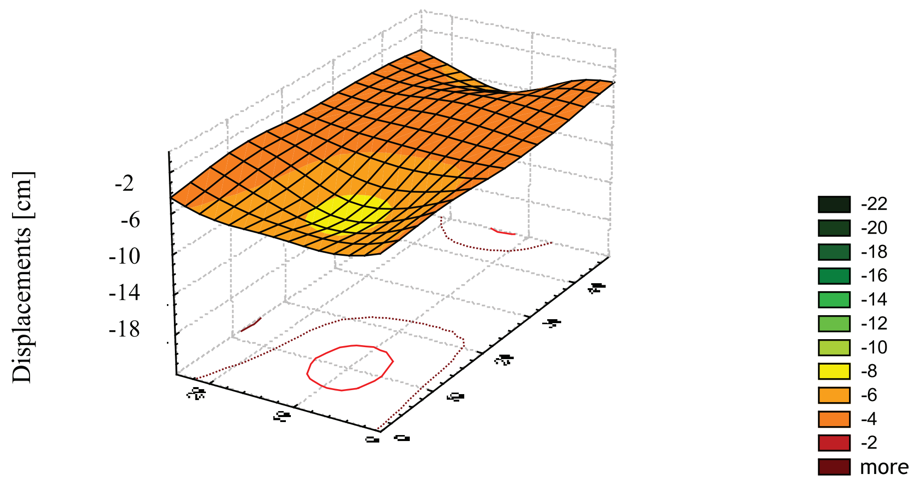

Figure 7. Deformation of the floor after 5 years

3 Conclusions

The importance of geodetic visualization results for interpretation of main object displacements and deformations is unquestionable. It is even more important for cases in which due to the dynamics of changes it is crucial to make quick and appropriate decisions.

Objective evaluation of any kind of the object defects that are likely to appear is possible thanks to incredible possibilities provided by computer developed graphics. In this way, various ways of spatial projections may be created with the help of different computer programs among which some deserve particular attention. These are the CAD group of software [2] and others such as STATISTICA which enables to present three dimensional space from any perspective. Furthermore, the visualization effect may be enhanced by an appropriate color combinations.

However, it should be remembered that computer is only a tool in the hands of a man and what really counts is the idea and skills of the designer.

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GEOMETRYCZNA INTERPRETACJA WYNIKÓW POMIARÓW OBIEKTÓW INŻYNIERSKICH

W artykule przedstawiono przykłady graficznej prezentacji wyników pomiarów przemieszczeń poziomych i pionowych oraz odkształceń wybranych obiektów. Monitorowane obiekty to kościoły: 80. letni i ponad 100. letni położony przy ulicy o bardzo dużym natężeniu ruchu oraz hala nowo wybudowanego obiektu. Wizualizacja wyników, głównie w układzie 3D, ma duże znaczenie dla interpretacji zmian geometrii obiektu w czasie oraz ustalenia przyczyn przemieszczeń i deformacji.