INVESTIGATION OF SHORT-TERM ROOF STRUCTURE DEFORMATIONS USING GEODETIC METHODS

M. Woźniak, W. Odziemczyk, S. Jastrzębski, J. Wojciechowski

Institute of Applied Geodesy
Warsaw University of Technology

1. ABSTRACT

The article contains the results of the measurements of the Warsaw University of Technology Main Hall roof deformations under various conditions. These results were obtained automatically using precise motorized tacheometres TDA5005 and TCRP2002. In this work we compare the vertical components obtained with tacheometric measurements to the results of geometric leveling for chosen control points. The aim of this research was the assessment of the usefulness of the proposed monitoring method to determine structural deformations.

2.INTRODUCTION

Control measurements of changes in object's geometry are necessary to ensure the safety of an object and its surroundings. The geodetic monitoring should satisfy high accuracy and reliability. For properly planning of control measurement we have to known about the nature of various factors of structure changes. The changes of structure can be divided as a short-term and long-term changes. To investigate short-term changes a quasi-continuous measurement of a chosen structure were made.

3. SHORT-TERM GEOMETRY CHANGES OF STRUCTURES

Structures whose measurements are regularly taken are also exposed to short-term effects of various factors, which may distort the results of their periodic measurements.
By short-term changes we mean the affects of factors over a short period of time, after which the structure "returns" to its initial state. The repetitiveness of short-term changes has all the features of systematic changes.
Short-term changes can be the subject of separate and detailed studies, the aim of which is :

- **to assess distortion size, consider the ways of eliminating distortions and carry out a thorough analysis of their origin,**
- **to plan a research timetable of long-term changes,**
- **to implement available data in reducing the results of long-term measurements,**
- **to select measurement methods of short-term changes.**

The structures especially prone to short-term changes are towers, outsize roofs, bridges, etc. Short-term geometry changes of these structures may be caused by gusts of strong wind, storms with a heavy downpour, structure overheating as well as other phenomena badly affecting the structure.
The size of short-term changes may even exceed long-term changes. Thus monitoring these changes is absolutely essential for the right assessment of how the structure works, and eventually, for its safety level.

4. STRUCTURE UNDER STUDY

The roof structure over the Main Hall of the Warsaw University of Technology was chosen for a short-term study, with a surface of over 2000 m2 and steel structure shown in Fig. 1.
In selected common points of the structure check points were placed in the form of prism reflectors (see Fig. 2).

Fig. 1. Roof structure general view

5. MEASURING SYSTEM

Geodesic monitoring was done with a specially designed TC-calc system. The organization of the system is shown in Schematic Diagram (see Fig. 3).
The system enables remote monitoring throughout the measurement process with a TDA 5005 instrument.
Measurements to monitor the geometry of the structure were planned for "load" changes along with the registry of load characteristics. For this purpose several automated stations were used, measuring temperature and atmospheric changes. Observations were made in a number of series, each lasting several days.

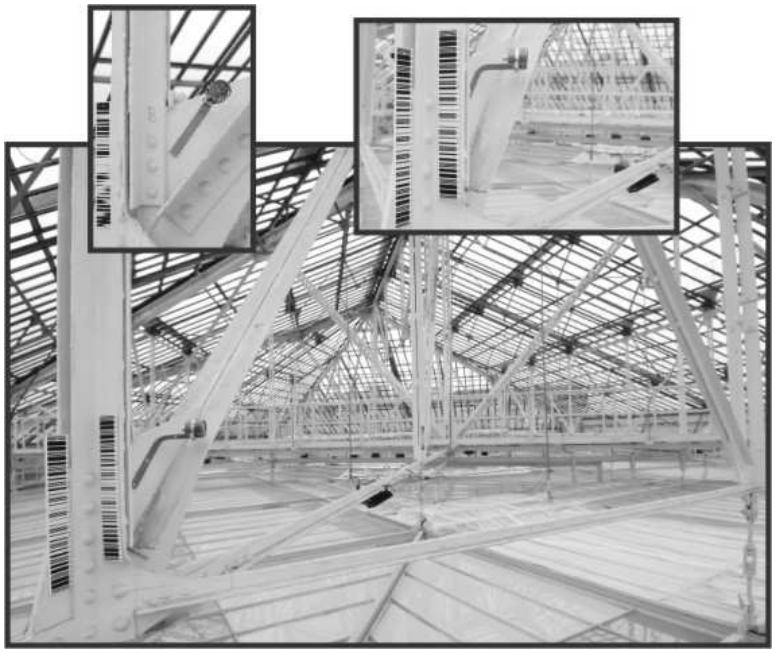


Fig. 2. Example of reflector fixing

Fig. 3. Organization of the TC-calc system

6. TC-CALC SYSTEM

The TC-calc was designed to carry out monitoring measurements for structure displacements. Its suitability for this type of measurements is determined by:

- **the possibility to define the position of observation stations, check points and their types all over the structure,**
- **the possibility to define the timetable of control measurements (the number of series and how they are spaced out),**
- **a number of measuring procedures enabling to process the results, including instrumental errors or influence of weather conditions.**

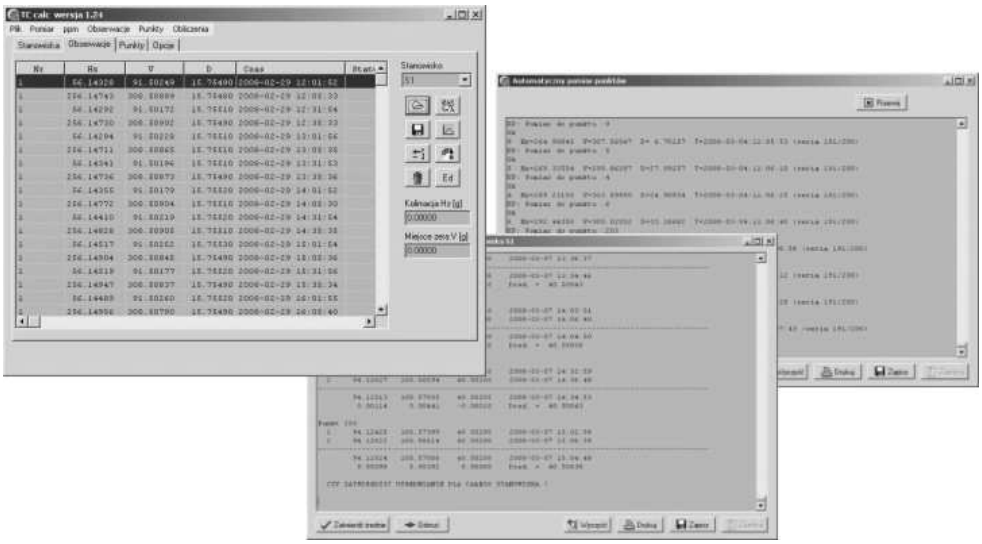
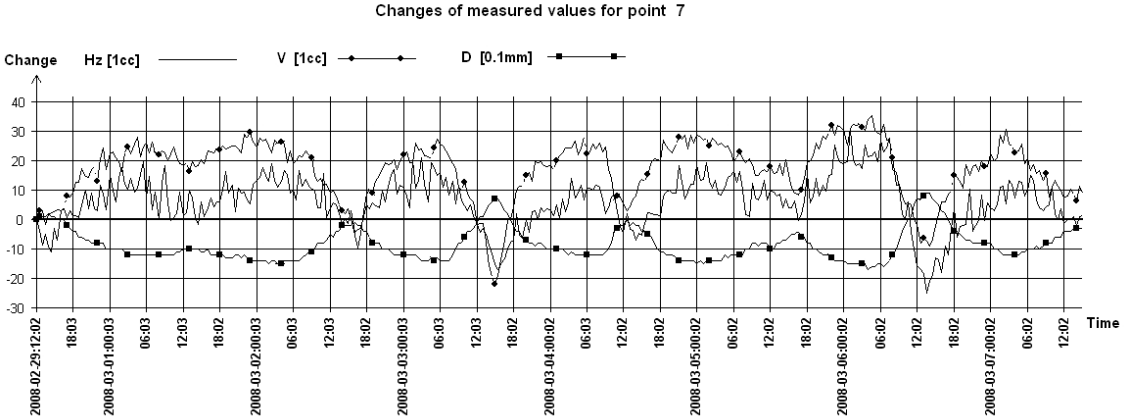
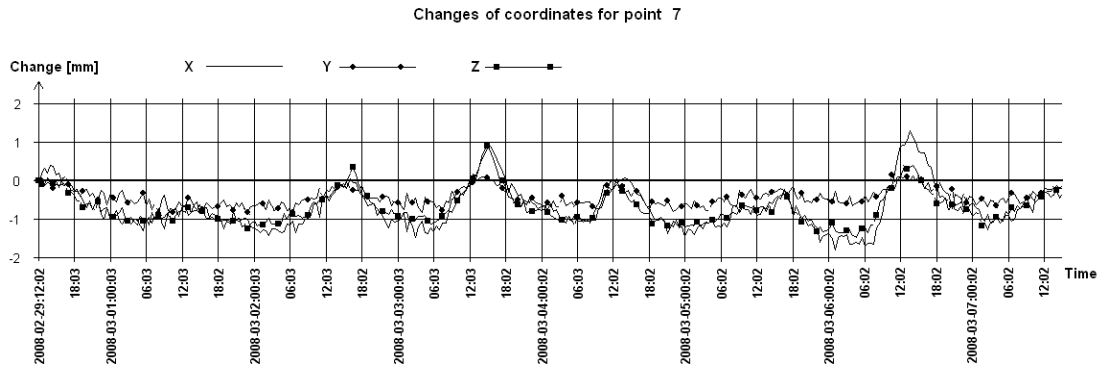


Fig. 4. System of communication windows in the program TC-calc

7. MONITORING

The results of observations were appropriately processed, obtaining a picture of changes of some chosen geometrical features of the structure.





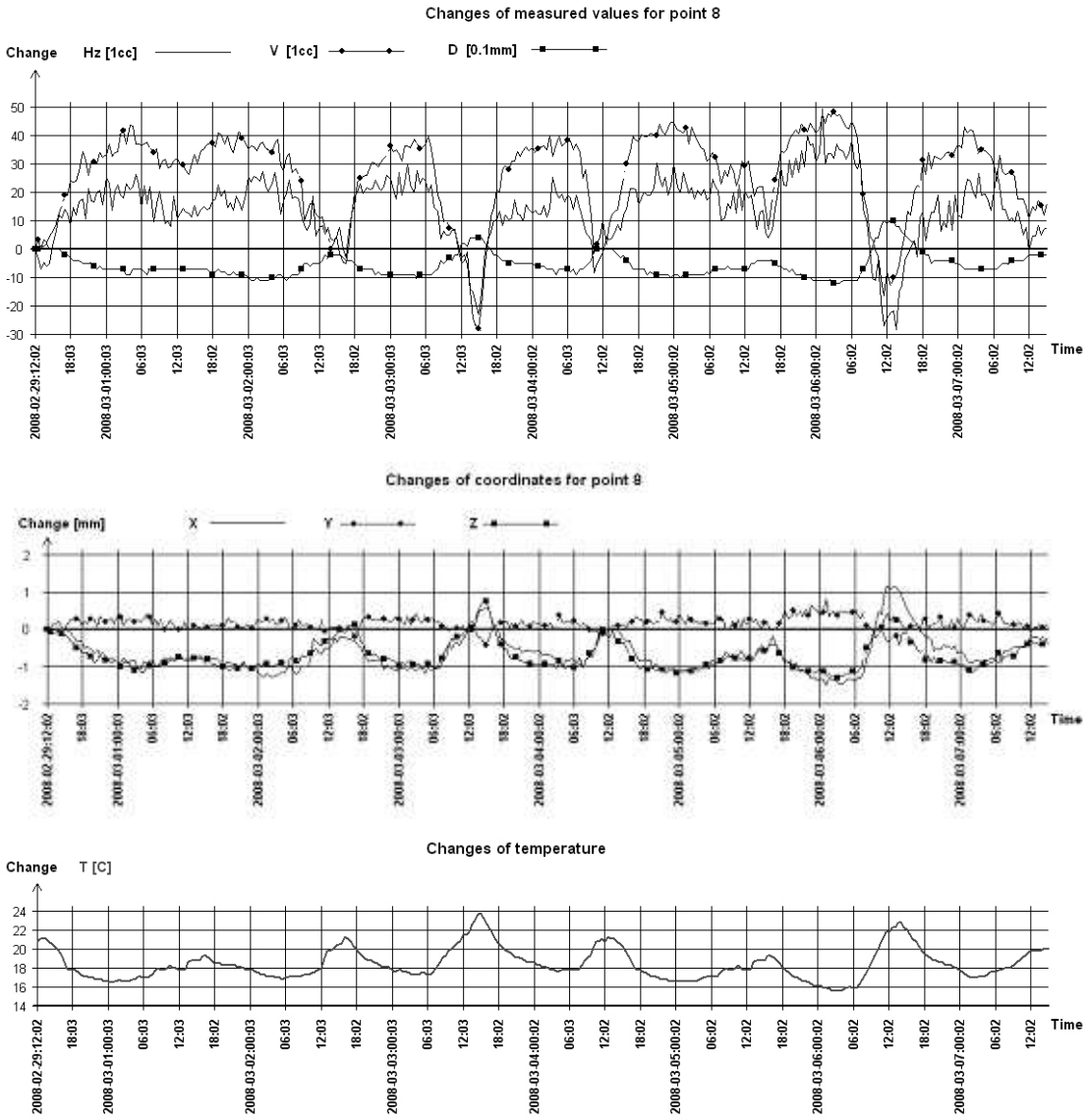


Fig. 5. Roof structure geometry changes diagram

8. CONCLUSIONS

- **The study confirmed the suitability of quasi-continuous monitoring of the structure for assessing how it works.**
- **Observation results analysis makes it possible to define correlation between changes in the structure geometry and its load.**
- **The applied technology of measurement enables to define geometry changes of a structure with an accuracy of ± 0.4 mm.**
- **The effect of local thermal anomalies on measurement accuracy were assessed along aiming lines.**
- **The TC-calc system proved its suitability for continuous monitoring. It would have been impossible to carry out such measurements in a traditional way.**

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