MONITORING OF THE WUT GRAND HALL ROOF IN CONDITIONS OF HIGH TEMPERATURE CHANGES

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1. ABSTRACT

Geodetic control measurements of changes in the geometry of an object should satisfy high accuracy and reliability. New tacheometers equipped with Automatic Target Recognition automatically moves the telescope to the center of the prism and supports control point measurements.
The accuracy of using an ATR system and the stability of an instrument in precise measurements were controlled in laboratory and field conditions.
This paper will present the results of monitoring measurements with a Leica TDA 5005 during the investigations of roof geometry in conditions of high temperature changes.

2. SHORT-TERM GEOMETRY CHANGES OF STRUCTURES

Geodetic control measurements of changes in the geometry of an object are necessary to ensure its safety and to evaluate of its imperfections.
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.
One of the factors is "the temperature load" of a construction.
The repetitiveness of short-term temperature changes has all the features of systematic changes.
The changes can be the subject of detailed studies, the aim of which is :

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

We present here the results of measurements of the Warsaw University of Technology Main Hall roof deformations under various temperature conditions in summer and winter. These results were obtained automatically using precise motorized tacheometres TDA5005 and a TC-calc measurement system.

3. STRUCTURE UNDER STUDY

The roof structure over the Main Hall of the Warsaw University of Technology with a surface of over 2000 m^2 and a steel structure was represented by 9 control points located in nodes of construction (see Fig. 1). In selected control points, prism reflectors were placed.

Permanent monitoring measurements were made using a precise motorized tacheometer Leica TDA 5005 supervised by a TC-calc system. The temperature conditions were extremely difficult both for the observer and for the instrument.
The temperature was over 48 degrees Celsius.
Only the use of a remote TC-calc measuring system made the measurements possible.

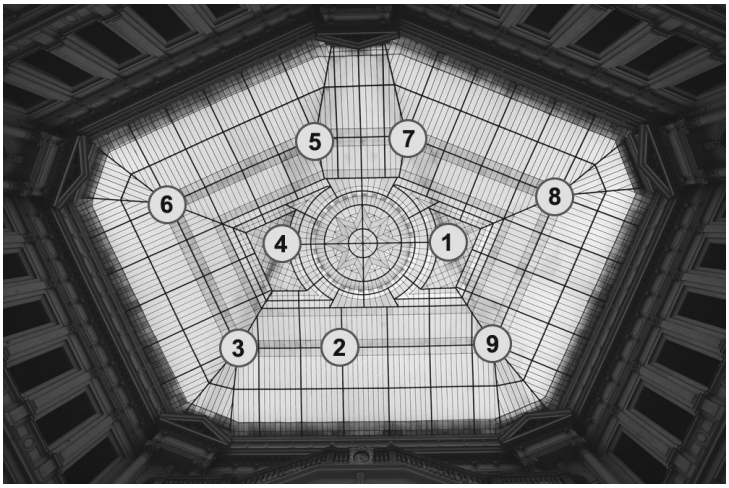

Fig. 1. Localization of control points on the roof.

4. MEASURING AND REGISTRATION SYSTEM

Experimental measurements were made with a specially designed TC-calc system using a TDA 5005 instrument (Fig. 2) and ATR mode. The Automatic Target Recognition (ATR) function of the instrument was very helpful during night observations. Mainly due to this option, quasi-continuous monitoring was carried out over three days at half an hour intervals.

Fig. 2. Tacheometer TDA 5005 in action.

The TC-calc system was designed to carry out monitoring measurements. Fig. 3 presents the communication windows of the TC-calc.

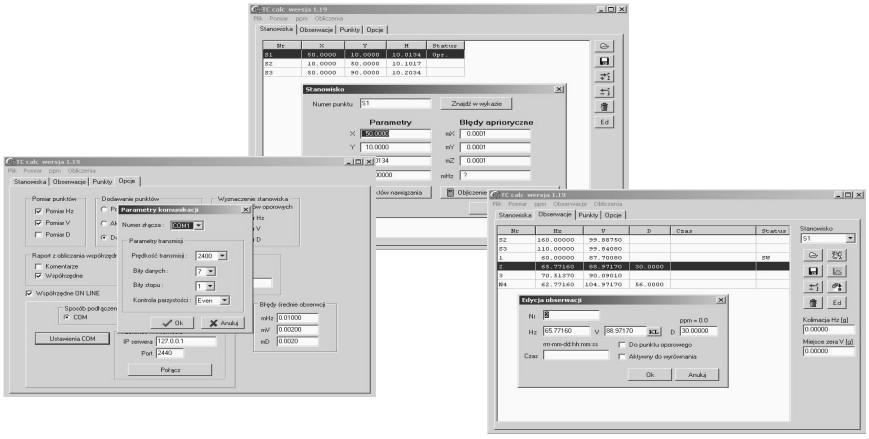

Fig. 3. View of the communication windows of a TC-calc system.

5. RESULTS OF MONITORING MEASUREMENTS

By analyzing the results of monitoring measurements we observed a very high impact of temperature on the instrument performance. In particular, changes were significant in collimation Hz and V. The magnitudes of those deviations are presented in Figures 4 and 5. There is a proportional relationship between temperature and collimation changes. Performing full series measurements eliminates this deviation.

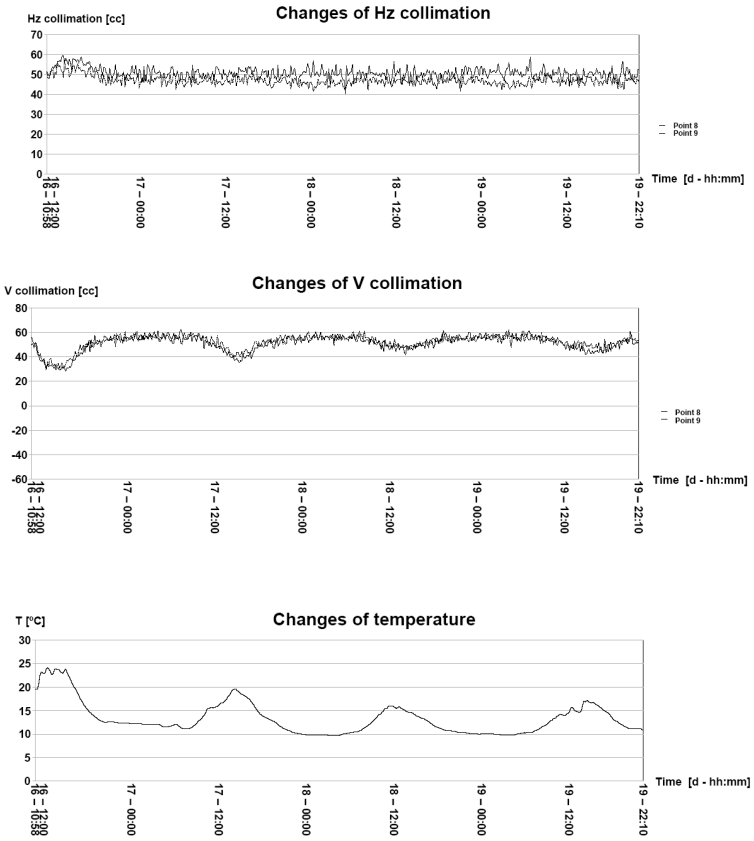

Fig. 4. Changes of Hz coll and V coll in relation to the temperature of an instrument in the winter season.

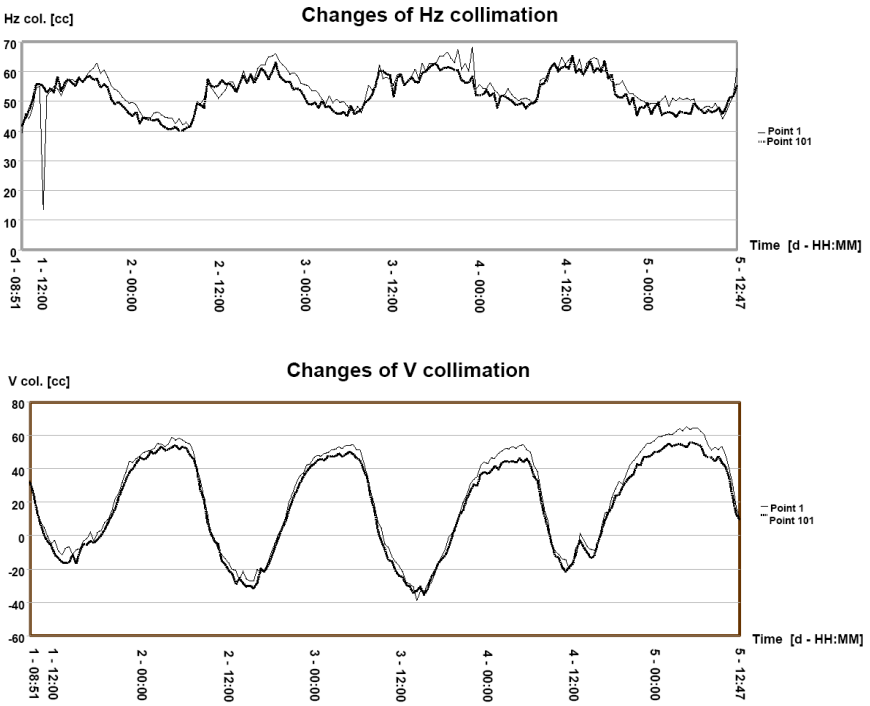

Fig. 5. Changes of Hz coll and V coll of the instrument in the summer season.

Even though the atmospheric conditions directly above the roof were extreme, we didn't observe significant changes in direction measurements to the reference points. We noticed, however, changes in control point positions far above the measurement mean error. The results of observations were appropriately processed, obtaining a picture of changes of chosen geometrical features of the structure (Fig. 6, 7). The position changes are strongly correlated with temperature fluctuation (Fig. 7).

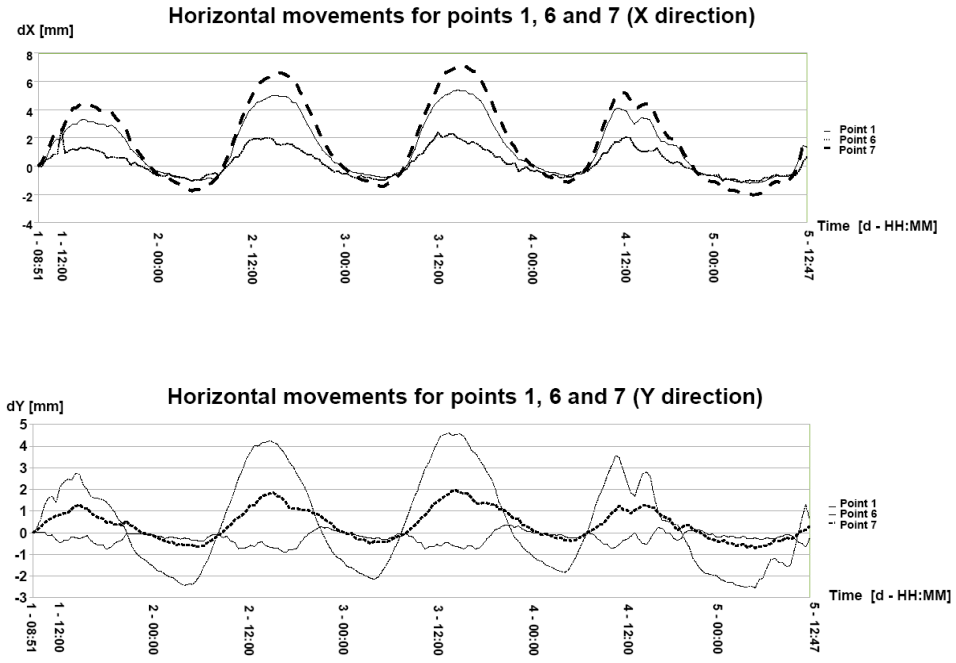

Fig. 6. Changes of X and Y coordinates of the control points.

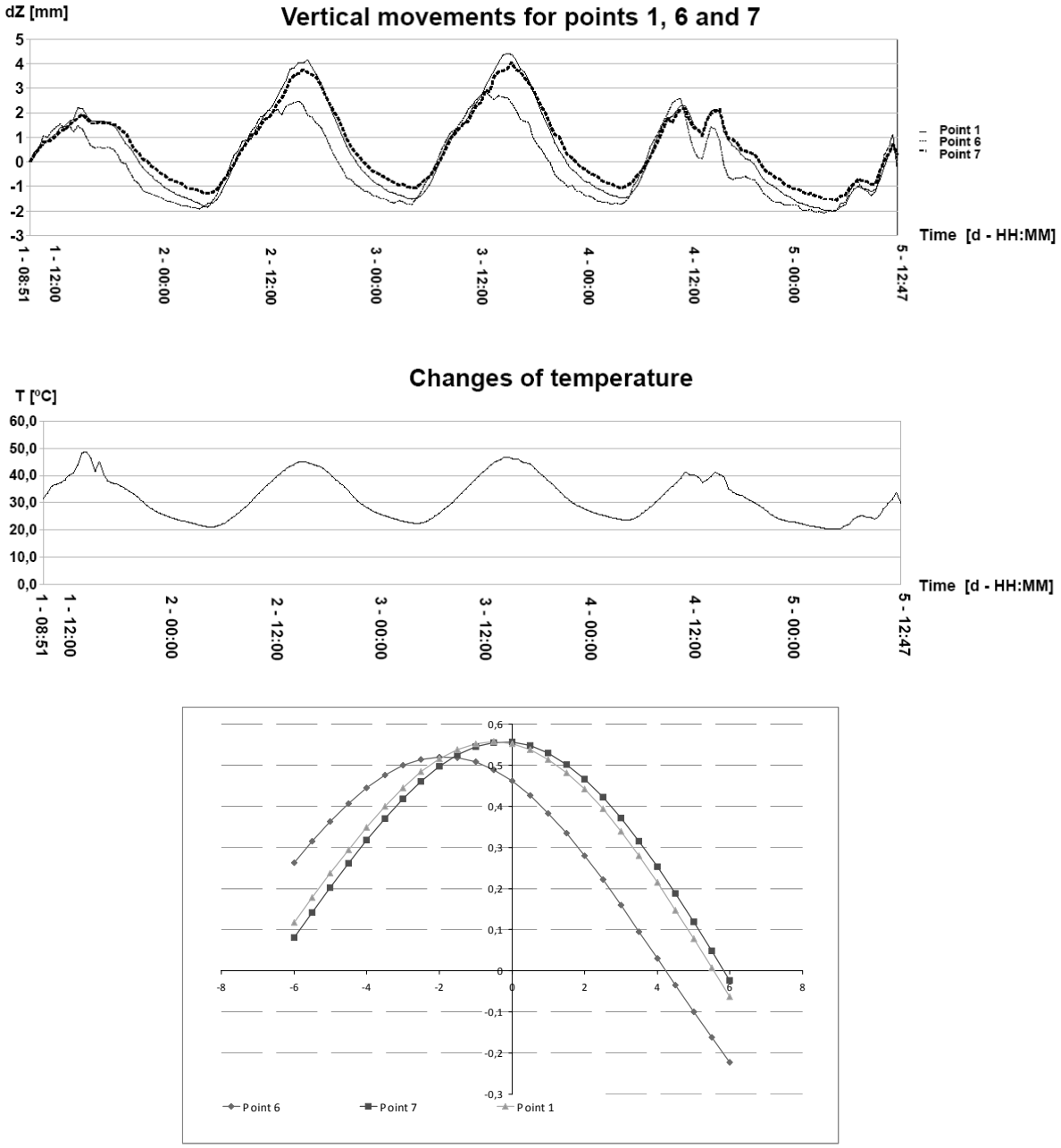

Fig. 7. Correlation factors for vertical changes of control points in relations to the changes of temperature.

6. CONCLUSIONS

1. The study confirmed the suitability of quasi-continuous monitoring of the structure for assessing how it works.

2. The analysis of observation results makes it possible to define correlation between the changes in the structure geometry and its "temperature load".

3. The applied technology of measurement enables to define geometry changes of the structure in such difficult conditions. It would have been impossible to carry out such measurements in a traditional way.

4. The displacements of control points located in the node of a construction is a valuable material for a construction analyst.

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