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GEODETIC AND CARTOGRAPHIC APPROACHES TO DETERMINING THE DEFORMATION OF BUILDINGS AND STRUCTURES

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Annotation: Geodetic and cartographic methods play a crucial role in ensuring the stability and safety of buildings and structures. This study analyzes modern geodetic technologies used for detecting and monitoring structural deformations. The significance of automated geodetic monitoring systems, sensors, and data analysis algorithms is examined. Additionally, the use of satellite observations, drone imagery, and digital cartography for monitoring and analyzing structures is explored. This research highlights the importance of geodetic and cartographic advancements in ensuring the long-term stability and safety of buildings.

Keywords: Geodesy, cartography, deformation monitoring, structural stability, digital cartography, satellite observation, drone imaging, automated geodetic systems.

Ensuring the long-term stability of buildings and structures is one of the most important scientific and practical issues today. During the construction process, engineering and geodetic surveys play a crucial role by enabling the early detection of potential structural deformations. With the advancement of geodetic and cartographic methods, modern monitoring systems have emerged, expanding the possibilities for automated analysis and assessment.

At present, the use of satellite observations, drone technologies, laser scanning, and digital cartography remains one of the most effective methods for monitoring structural deformations. These technologies enable real-time tracking of deformation processes in buildings, facilitate data analysis, and allow for the early prediction of potentially hazardous changes.

In this context, the present study is dedicated to examining modern geodetic and cartographic methods used for detecting deformations in buildings and structures. The research analyzes key aspects of deformation monitoring, modern technologies, and the effectiveness of their application.

1. Scientific Foundations for Detecting Structural Deformations

The deformation of buildings and structures directly affects their load-bearing capacity and long-term operational efficiency. The main factors causing deformation include:

Geological processes (such as the rise of groundwater levels and changes in soil density);

Seismic impacts and tectonic shifts;

Changes in the physical and mechanical properties of construction materials;

Environmental factors (including temperature fluctuations, humidity, and wind pressure).

Geodetic surveys enable the measurement of deformation parameters in structures, which is essential for ensuring their safety.

2. Modern Geodetic and Cartographic Methods

The following modern technologies are widely used in the monitoring of structural deformations (Figure 1).

Figure 1. Modern monitoring systems for detecting structural deformations.

Satellite Monitoring.

Satellite imagery enables the detection of ground movement and deformation dynamics of buildings and structures. Interferometric Synthetic Aperture Radar (InSAR) technology is one of the most effective methods in this field, capable of capturing changes at the millimeter scale.

LiDAR Technology and Laser Scanning

LiDAR (Light Detection and Ranging) technology allows for precise and rapid monitoring of deformation processes in structures. Using laser beams, three-dimensional models are created, and changes are observed in real time.

Aerial Photogrammetry Using Drones

Drone technologies serve as an important tool for monitoring structural deformations by providing high-resolution images of buildings and structures. This method is more cost-effective and faster compared to satellite imagery, especially useful in areas with complex terrain.

Automated Geodetic Systems

Automated monitoring systems are being implemented to track deformations of multi-story buildings in real time. These systems consist of continuously operating geodetic stations, motion sensors, and data processing software, enabling ongoing observation of deformation processes in structures.

3. Monitoring of Structural Deformations in the Context of Uzbekistan

Several projects aimed at monitoring the deformations of buildings and structures are being implemented in Uzbekistan. In particular, monitoring activities using modern geodetic and cartographic technologies are carried out in major cities such as Tashkent and Samarkand.

To ensure construction safety, the technical condition and deformation processes of structures are monitored through the country's cadastral system.

The Law of the Republic of Uzbekistan "On Land Cadastre" and other regulatory documents require systematic geodetic monitoring of buildings and structures.

CONCLUSION

Modern geodetic methods play a crucial role in detecting and monitoring deformations of buildings and structures. The study has shown that satellite monitoring, LiDAR technology, drone imagery, and automated monitoring systems provide accurate, systematic, and reliable data in real time. These approaches enable early detection of any tilting, subsidence, or deformation processes in structures.

Moreover, geodetic monitoring systems are essential for forecasting hazardous changes, assessing the technical condition of construction objects, and ensuring their long-term stability. In the context of Uzbekistan, the practical implementation of these technologies can enhance safety and reliability in large infrastructure projects.

The results of the research indicate that geodetic approaches form the fundamental basis for modern structural monitoring and contribute significantly to their effective operation.

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