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Deformation Monitoring

SURVEYING PRECISION

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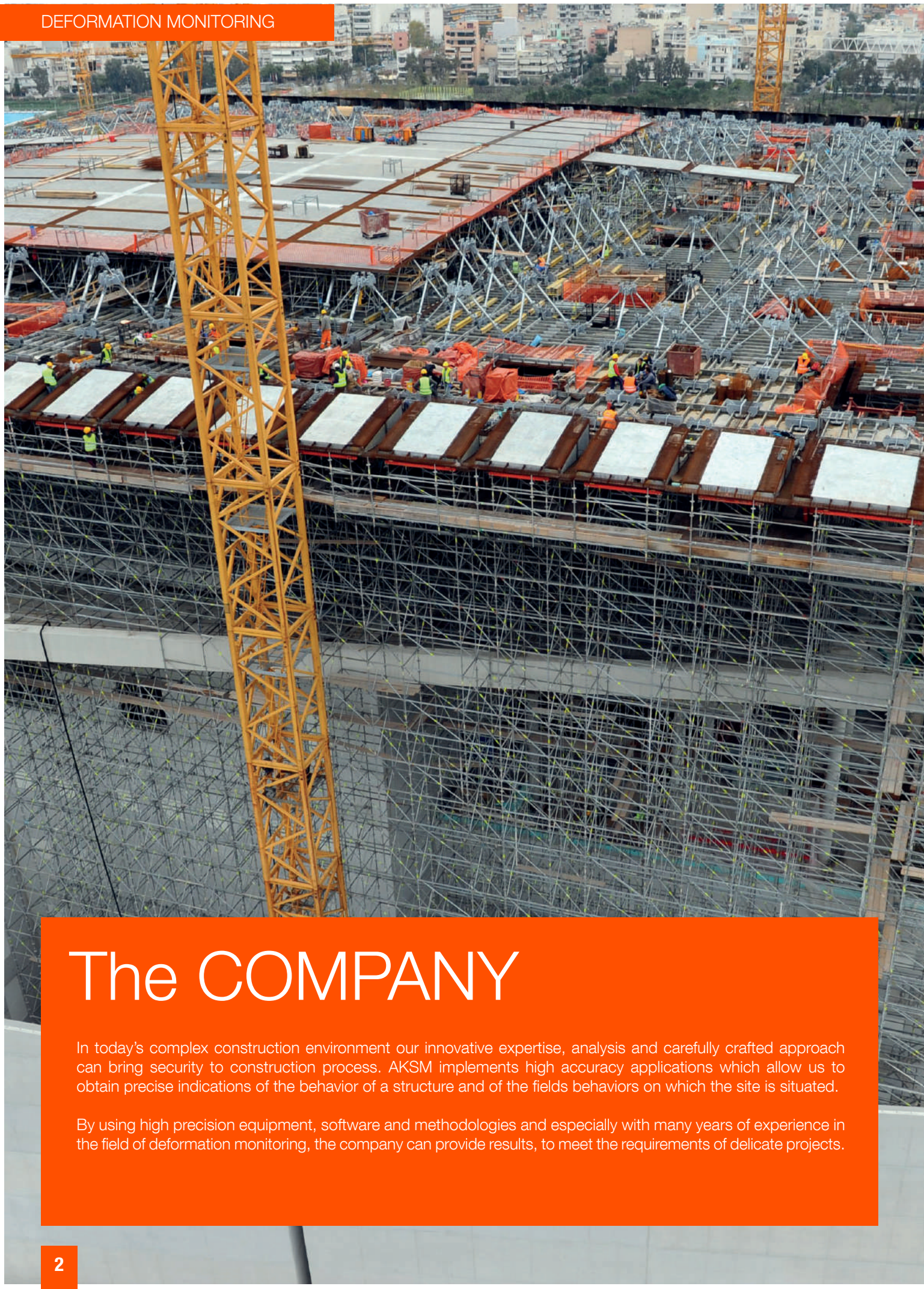
land-building-industrial
SURVEYING & MAPPING



The COMPANY

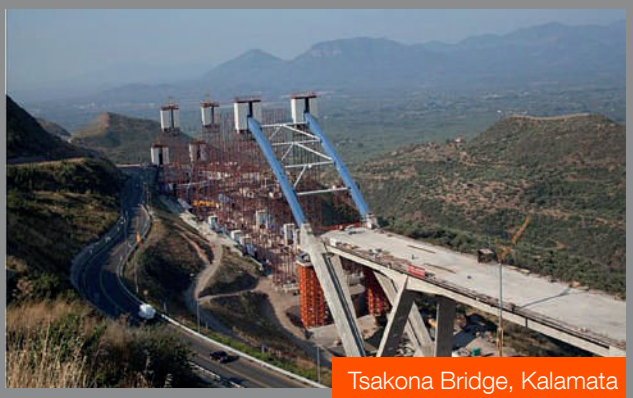
In today's complex construction environment our innovative expertise, analysis and carefully crafted approach can bring security to construction process. AKSM implements high accuracy applications which allow us to obtain precise indications of the behavior of a structure and of the fields behaviors on which the site is situated.

By using high precision equipment, software and methodologies and especially with many years of experience in the field of deformation monitoring, the company can provide results, to meet the requirements of delicate projects.

DEFORMATION MONITORING

The deformation monitoring of a land or construction represents a systematic action of observation, measurement and analysis of the way they respond to influence of surrounding agents, taking permanently in consideration the projection parameters of functionality, stability and safety.

For a proper monitoring of construction behavior in time constructions that are subjects to experimental solicitation obtaining observations in a relative short time in highly required.



Tsakona Bridge, Kalamata

METHODOLOGY

AKSM implements an instrumentation and monitoring system (MYSYS) that meets all the requirements specified by design. For each work section in a project, proposals are submitted for the setup of the geodetical monitoring system to the Client.

Office Complex Building of Anangel, Kallithea, Attica

1. LEVELLING MEASUREMENTS

A. Buildings - structures

Levelling measurements are taken on levelling pins installed at the ground surface (road surface, sidewalks, etc.) or on buildings and / or on deeply embedded rods. The levelling pins on a surface or on buildings (e.g. vertical features, columns and walls) are of the embedment screw type of galvanized steel. Alternatively, where drilling and embedment is impossible, levelling contact pins are used with an aluminium plate or corner and a steel ball suitably adhered to a hemispherical hole of same diameter. The measurements of the levelling points are carried out with a precision of at least ± 1mm per kilometer and always with open levelling routings, completely dependent from their two ends on the levelling starting points (benchmarks) with known elevation. The instruments and their accessories (remote distance devices, tripods, etc.) are serviced, checked according to the instructions of the manufacturer and will be replaced when it is necessary.

Stavros Niarchos Founadtion Cultural Center

B. Ground surface above tunnels

Sections and grid of pins according to the monitoring design plan are installed. The distance between the pins of each section is subject to the design study. On the road pavements, the layout varies depending on the actual conditions.

Public Store, Syntagma, Attica

C. Influence zone free field (in all other cases except the above)

Pins are developed on a grid covering the entire influence zone. Pins that cannot be installed (e.g. in streets with heavy traffic) can be placed and measured at any other location further to pertinent communication with Client.

2. CONVECTIONAL THREE-DIMENSIONAL TOPOGRAPHICAL MEASURING SYSTEMS

Three dimensional displacement measurements (3D) are carried out within the Zone of influence in order to determine the movement on adjacent to the project structures and buildings. Reflectors are installed in tunnels, structures, etc. and the measurements are made with high precision total stations by the method of free station.

The reference network of the points, that is used for 3D measurements, consists of reference points with permanent labelling at the locations outside the zone of influence of the works or at locations remote to the excavation faces. The reference network will be checked at regular time intervals. All the measurements are corrected by the impact of the pressure and temperature diffractions. The precision of the measurements of total displacements is ± 2mm.

3. AUTOMATED MONITORING SYSTEM (AMS) OF REAL TIME TOTAL DISPLACEMENTS (3D)

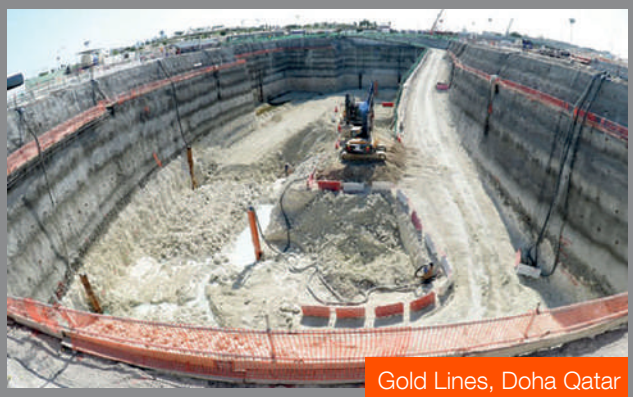
The system consists of a high accuracy networked robotic total stations and prisms located on the point of interest. This system ensures valuable and timely monitoring of the displacements, providing high measurements density, simultaneous wireless transmission and entry of the results into the MDB system to ensure minimal time between their reading and their evaluation.

The measurements are taken with a series of automatic electronic total stations of high precision, which will record the displacement of reflecting prisms on the ground surface and on buildings. The robotic total station is capable of carrying out automatic measurements, both at predetermined sequences and at any arbitrary time and the maximum measurement range is in accordance with with the environmental conditions.

The total stations are remotely controlled by software and are capable of:

- Following a pre-programmed operation
- Allowing changes in the measurement regime to be implemented , including the measurement cycle
- Providing continuous data for one point

The system allows the above changes to be made remotely via internet connections. The instruments are capable of self-seeking a point that has been moved by at least 30mm without affecting the monitoring regime/ data return time adversely.



Gold Lines, Doha Qatar

WFGD UNIT at UNIT III of PPC S. A Megalopolis

Underground Parking, Kifisia, Attica

Hill Area at SNFCC

APPLICATIONS

In particular, some of the applications of this methodology have been used in:

- Dams
- Roads
- Tunnels
- Bridges and overpasses
- Multistory and historical buildings
- Foundations
- Mining-exploitation
- Landsides and sloping
- Earthquake-prone regions

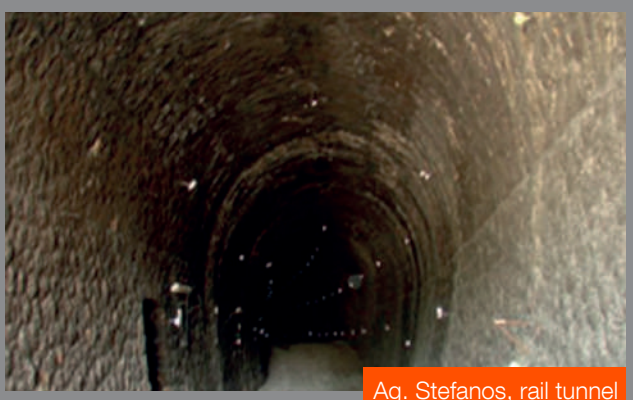
PROJECTS

- Karouzos Shopping Center at Larisis Train Station, Attica. Deformation monitoring on piles and on adjacent buildings and structures during earthworks periods.
- New Office Complex Building of Anangel Shipping Company, Kallithea, Attica. Deformation monitoring on piles and on adjacent buildings and structures during earthworks periods.
- 6-floor Underground Parking Building, Kifisia, Attica. Deformation monitoring on piles and on adjacent buildings structures during earthworks periods.
- Rea Maternity Hospital, Piraeus, Attica. Deformation monitoring on piles and on adjacent buildings and structures during earthworks periods.
- ”Gold line Underground”, Doha, Qatar. Deformation Monitoring across the Zone of influence on buildings and structures (16m).
- Public Store, Syntagma, Attica. Deformation Monitoring on erected building during foundation expansion.
- Tsakona Bridge, Kalamata. Automated monitoring system (AMS) installed for deformation monitoring on frame bases during erection period.
- Minion Multistore, Syntagma, Attica. Deformation Monitoring on erected building during foundation expansion.

Minion, Multistore, Attica

Karouzos Station Shopping Center, Attica

Opera Auditorium at SNFCC



Ag. Stefanos, rail tunnel

- WFGD UNIT at UNIT III of PPC S. A, Megalopolis
- Real time deformation monitoring on tanks surface during hydrotest period.
- Structural monitoring on structures and buildings across the project's boundaries during erection period.
- High accuracy monitoring network establishment consisting of 170 monitoring prisms on structures in the zone of influence.
- Zero measurement calculation for long term monitoring reasons.

- Stavros Niarchos Foundation Cultural Center (SNFCC), Kalithea
- Deformation monitoring on structures and adjacent buildings around the site.
- Deformation monitoring and landslide examination on structures during earthworks period.
- Automated Monitoring System (AMS) installation – deformation monitoring on support frames during casting.
- AMS installation – deformation monitoring on Canopy's period during depropping and uplift period.

- ''Gold Line Underground'', Doha, Qatar
- Network installation in the Zone of influence (ZOI).
- Monitoring prism and pins installation on structures and buildings in the Zone of influence.
- Deformation monitoring – Automated Monitoring System (AMS) installation.
- Deformation monitoring on piles and on adjacent buildings and structures during earthworks periods.

WFGD UNIT at UNIT III of PPC S. A, Megalopolis

Gold Line Metro, Doha

CASE STUDY: DEFORMATION MONITORING AT CANOPY OF STAVROS NIARCHOS FOUNDATION CULTURAL CENTER

The ferrocement canopy of the Opera Building is made out of two 100m x 100m ferrocement skins: the superior one (top skin) and the inferion one (bottom skin); they are connected together by Ferrocement diaphragms and steel diagonal circular hollow tube sections. The Canopy Roof is supported by 30 columns through bolted connections to the column bases embedded in the concrete. On the top through bolted connection to the column heads provided with spring dampers and connected to the roof.

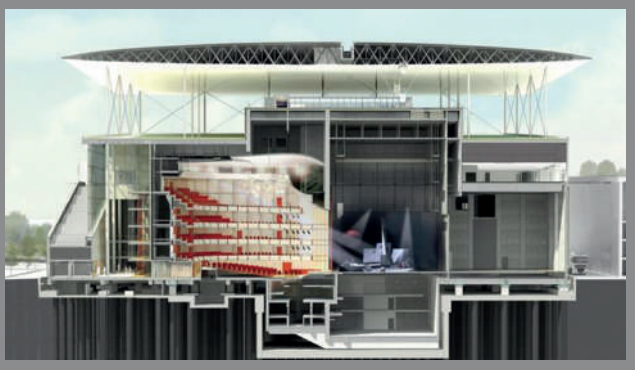
Since deproping was not executed by removing the props (the number of props does not allow a controlled procedure) and took place by uplifting the canopy from the column heads, it has been required for a AMS to be installed in order to calculate the deformations on canopy's surface as a result to the uplift sequence.

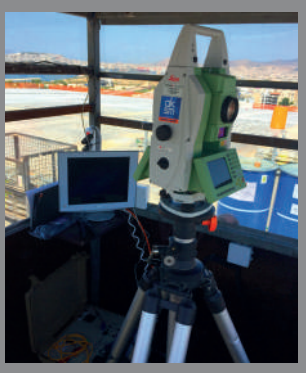
In order to calculate the deformation, on the canopy's surface in relation to the uplift values the following schedule has been followed:

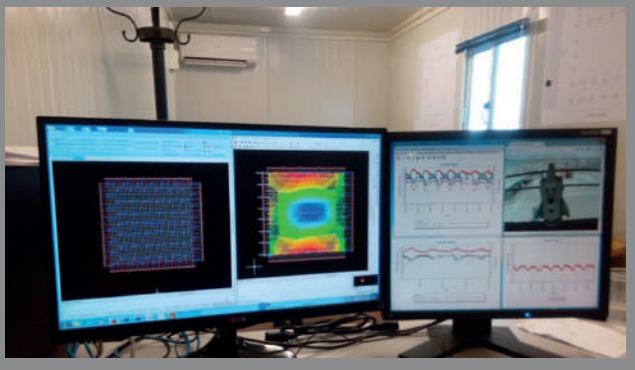
- Uplift values were recordered through an LVDT indicator installed on the column head.
- Deformation values on the column base were calculated on a daily basis through high accuracy levelling.
- Deformation on the Canopy's surface were calculated through monitoring prisms installed on the casted surface (pre-installed couplers on skins) and a Robotic high accuracy station (Leica TS -30).
- Data were collected every two hours and were post processed through a SQL Based Database for monitoring data analysis (Terramove). Through the long term data collection and analysis and through the deliverables consisting of:

  - adjusted values
  - deformation diagrams (Dx, Dy, Dz)
  - deformation contours,

  the deformation behavior of the structure was analyzed on a 24h basis, monthly basis, 3 months basis, etc.







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