



Test Smart - Build Right



Test Right – Sleep Tight

## Report from the

# 2<sup>nd</sup> International Educational Workshop on CONCRETE SCIENCE & ADVANCED METHODS FOR EVALUATION OF CONCRETE with emphasis on deteriorating bridges Greece, May 3-6, 2022



Conducted at the Stavros Niarchos Foundation Cultural Center, Athens, Greece



...and the bridge B044 close to the Corinth Canal, Peloponnese, Greece

## TOPICS

**In-place concrete strength** (cores, pullout, pull-off, rebound hammer, UPV and maturity)

**Integrity of structures** (impact-echo, ultrasonic-echo and impulse-response)

**Reinforcement** (Covermeters and GPR)

**Durability** (Design - Materials - Mixture Proportions - Construction Practice & Resistance to Penetration of Water and Harmful Ions)

**Grout injection** (of post-tensioned cable ducts and structural joints by impact-echo and ultrasonic-echo)

**Corrosion** (half-cell potentials, electrical resistance, and corrosion rate)

**Curing** (evaluation by pullout and conductivity tests and implication on service life)

**Service life** (chlorides, profile grinding, diffusion of harmful ions, start of corrosion and service life)

**Fresh concrete** (air-voids, rheology, shrinkage)

**SMH** Structural Health Monitoring

**Drones** for inspection

## **The Test Systems**

### **Evaluation of in-place concrete strength**

- **LOK-TEST** and **CAPO-TEST** Pull-out test
- **BOND-TEST** Pull-off
- **CORECASE** for core testing
- **COMA-Meter** maturity

### **Flaw detection based on stress waves**

- **DOCTer Viking** Impact-echo
- **MIRADOR** Impact-echo
- **s'MASH** Impulse-response method
- **MIRA** Ultrasonic-echo
- **PULSAR** and **Surfer** Ultrasonic pulse velocity

### **Location of reinforcement**

- **CoverMaster**
- **GPR** Ground Penetrating Radar

### **Reinforcement corrosion**

- **Durability** principles
- **GWT** Water penetration
- **RCT** Chloride content
- **Deep Purple, Rainbow**, depth of carbonation
- **Profile Grinder** for chloride profile and
- **Service life** estimation
- **Mini Great Dane** Half-cell potential
- **GalvaPulse**, corrosion rate, HCP & resistivity
- **Merlin**, Concrete conductivity / resistivity
- **PROOVE'it** Rapid chloride penetration

### **Advanced test methods**

- **AVA** Air-void characteristics of fresh concrete
- **ICAR Rheometer**, concrete rheology
- **Auto-Shrink**, autogenous shrinkage

In 25 slide presentations the science behind each test system was explained in detail by top academics and cases were given by NDTitan professionals, p.10. The test systems are described on

[www.germanninstruments.com](http://www.germanninstruments.com)

And + 30 cases on

[www.NDTitans.com](http://www.NDTitans.com)

## **The Participants**



**The workshop participants from Sweden, Norway, UK, Czech Republic, Slovenia and Greece, together with the lecturers and the instructors**

## The Lecturers



### **Dr. Nicholas J. Carino**

**Concrete Technology Consultant, USA**

[ncarino@roadrunner.com](mailto:ncarino@roadrunner.com)

Dr. Nicholas Carino is an internationally recognized researcher, author and educator on NDT and standard test methods. He retired from NIST after 25 years of service and is an independent consultant. He has served in many leadership positions on ACI and ASTM Committees.

Dr. Carino received many awards from ACI and ASTM for his contributions in research and standards development. He is an Honorary Member of ACI and a Fellow of ASTM.

Dr. Carino is responsible for the technical content of the highly-acclaimed NDT Workshops organized by Germann Instruments and international partners. These workshops are a unique blend of fundamental concrete science and the principles of advanced NDT methods.

### **Dr. Andrzej Moczko**

**Professor at Faculty of Civil Engineering  
University of Science and Technology Poland**

[andrzej.moczko@pwr.wroc.pl](mailto:andrzej.moczko@pwr.wroc.pl)

Specialist in Non-Destructive Testing and evaluation of building structures. He has more than 25 years of experience in the practical application of DOCTer Impact-Echo system for flaws and thickness, and the s'MASH Impulse Response system for rapid screening of flaws, Lok-Test and CAPO-Test for in-place compressive strength assessment; the Bond-Test for bond strength evaluation. maturity method for estimation of strength development; GWT water permeability testing, Rapid Chloride Test and corrosion.



### **Mr. Guy Rapaport**

**Ramboll Finland OY – Finland**

[guy.rapaport@ramboll.fi](mailto:guy.rapaport@ramboll.fi)



Mr. Rapaport covering the topics related to practical experience in bridge testing, specialized in detection of voids in cable ducts with MIRA ultrasound and DOCTer Impact-Echo. He has 25 years of professional experience in the field of bridge engineering. He is acting at present as a Leading Consultant, NDT Business Manager and Project Manager in Ramboll Finland Oy. He is specialized in bridge repair planning, bridge- and concrete structures inspections and in state-of-the-art Nondestructive Testing (NDT) of concrete structures / bridges, including validation of NDT results.

## Mr. Nichos Zoides

GEOTEST SA – Greece  
[nzoidis@geotest.gr](mailto:nzoidis@geotest.gr)

After finishing his M.Sc. from the Technical University of Crete, he started his professional career in the Construction Industry as QA/QC quality control engineer on large infrastructure projects in Greece. In 2003 he co-founded Geotest SA with main activities in the quality control of construction materials, non-destructive test and inspections of concrete structures, not at least especially industrial floors with s´MASH Impulse Response and DOCTer Impact-Echo, and has been the company CEO´s ever since. Specialist in drones



## Mr. Hugo Orozco

Germann Instruments A/S  
Denmark  
[hugo@germann.org](mailto:hugo@germann.org)



Civil Engineer and MBA with 16 years of experience in the assessment of reinforced concrete structures. He is specialized in various NDT techniques, the science of concrete deterioration, service life calculations, and the implementation of strategies for damage prevention, protection, repair and structural strengthening, especially with fiber reinforced polymers (FRP composites). He worked for Sika Mexico as a Product and Market Manager in charge of the marketing, development and technical support for the portfolio of solutions for concrete repair and protection, grouting, structural bonding, chemical anchoring and structural strengthening with FRP.

## Dr. Gabriel Sas

Professor  
Luleå University of Technology  
[gabriel.sas@ltu.se](mailto:gabriel.sas@ltu.se)

Gabriel Sas, born in 1981 in Romania, defended his PhD in 2011 at Luleå University of Technology with a dissertation on how to strengthen existing concrete structures. Shortly afterwards, he worked in Norway in the Research and Development sector. He led one of the largest research project in the hydropower industry in Norway, where they worked to extend the life of existing dams. He is now a professor of structural engineering at LUT. At the workshop he lectured in Structural Health Monitoring (SMH) with special reference to the Swedish Kalix Bridge Project.



# On-Site Demomstrations, bridge B044, Peloponnese, Greece



Participants at the bridge

Demonstrations covered Coring, Bond-TEST, Capo-TEST, GWT, Profile Grinder and RCT, GalvaPulse, Rainbow Indicator, Surfer, Pulsar, DOCTer Impact-Echo, s'MASH Impulse Response, MIRA Tomographer and Drones, described shortly in the following

## Coring and BOND-TEST



Preparation for the BOND-TEST, coring around the disc glued on prepared surface



Mounting the hydraulic pull machine, ready for pull-off

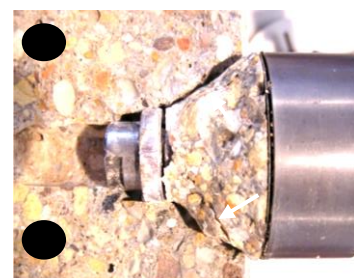
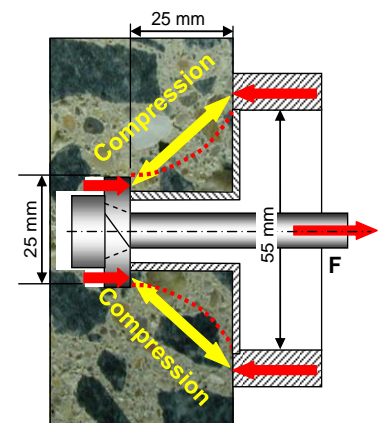


Tensile failure of the concrete. Max pullforce registered and divided by the area to get the MPa's

## CAPO-TEST

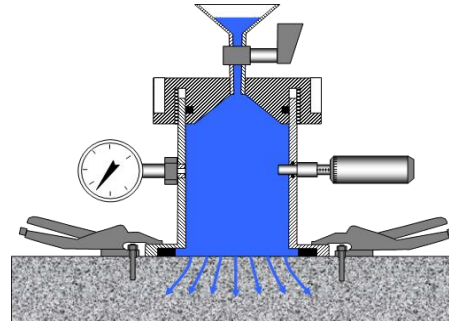


CAPO-TEST in progress on the abutment



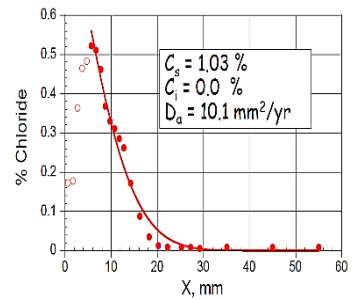
CAPO-TEST. Note in the right photo the parallel circumferential cracking (white arrows) in the compression zone, the "Strut", hence the pullout force is a direct measure of compressive strength. Correlation to compressive strength by one general relationship.

## GWT



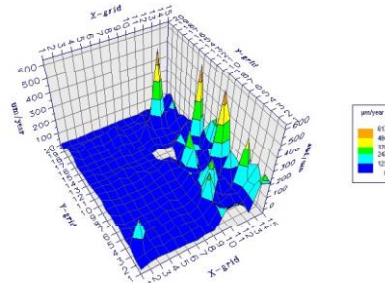
GWT, Germann's Waterpermeation Test. A selected water pressure is maintained by the micrometer gauge pressing a pin into the water chamber measuring the amount of water penetrating the concrete

## Profile Grinder and RCT



Profile Grinding, followed by testing for chlorides on-site with the RCT of the concrete powders and establishment of a chloride profile for service life estimation

## GalvaPulse



GalvaPulse for corrosion rate, half-cell potentials and electrical resistance of the cover layer, corrosion rate 3D-mapping shown

## Rainbow Indicator



Rainbow Indicator sprayed on the CAPO-TEST cone hole, pH < 5 (red color)- totally carbonated

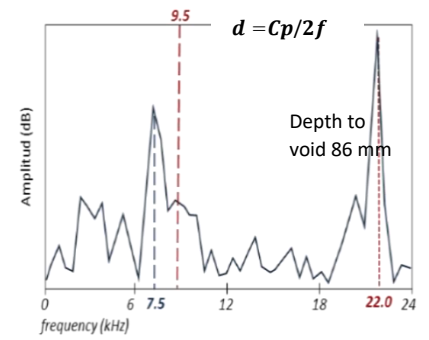
## Surfer and Pulsar



Surfer for surface wave speed and depth of surface opening cracks < 100 mm

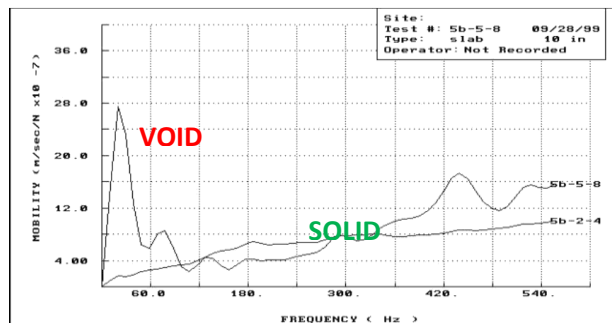
Pulsar for UPV

## DOcter Impact-Echo



DOcter Impact-Echo for defect detection by reflection of P-wave generated by impact with a selected small steel ball. With two transducers on the surface P-wave speed can be estimated accurately, as well as depth of surface opening cracks. Right figure show the frequency spectrum with an indication of a flaw – an air interface - at a depth of 86 mm for a P-wave speed of 3785mm/s. MIRADOR impact-Echo system for 3D visualization.

## S`MASH Impulse Response



S`MASH transducer and instrumented hammer producing mobility plot for rapid screening of anomalies. Typical mobility shown to the right for delamination as well as a solid response.

## MIRA Tomographer



MIRA in action, using shear waves from multiple transducers, followed by 3D-mapping of defects

## Drone demonstration



All test systems are detailed on

[www.germanninstruments.com](http://www.germanninstruments.com)

# Diplomas and testimonials



Diplomas presented to the attendees by Mr. Nicholas Zoides, Dr. Nick Carino and Mr. Claus Germann Petersen at the Dinner



*“Excellent workshop, in general I found all the material to be understandable and comprehensive”*

*“I got a good general understanding of NDT, it was very interesting with the theory and the site demonstrations at the bridge”*

*“Thank you, it was an excellent workshop, great presentations, and demo of the NDT methods at a real bridge”*

*“Thank you for your efforts, the site demos were the most important at this workshop. I enjoyed it. Excellent!”*

*“Would prefer as many case studies as possible following the theory, the site demos were excellent and most important”*

*“Well executed, excellent workshop. However, I recommend more time for discussions”*

*“Well done, excellent workshop”*



## Congratulations and good Luck!



# **GOLD MEDALS**

Following the Diploma recognition of the attendees, NDTitan Gold Medals were given by Mrs. Mariana Lara, CEO, to selected members of the NDTitans in appreciation of their excellent and long-time, valuable contributions to the NDT society.



The five proud Gold Medal recipients: Mr. Hugo Orozco, Mr. Guy Rapaport, Dr. Andrzej Moczko, Dr. Nick Carino and Mr. Nikos Zoides together with Mrs. Mariana Lara, CEO and Mr. Claus Germann Petersen, CEO

Two more recipients of the NDTitans GOLD MEDAL were unable to attend:

Mr. Sal Fasullo, Canada and  
Mr. Parampret Singh, India

They will receive their Gold Medals as soon as possible for their excellent work in NDT



Dr. Nicholas Carino,  
USA



Dr. Andrzej Moczko,  
Poland



Mr. Claus G. Petersen,  
Denmark



Mr. Parampreet Singh,  
India



Mr. Bernie H.  
Hertlein, USA



Mr. Malcom K. Lim,  
USA



Mr. Todd Allen,  
USA



Mrs. Kirsten Eriksen,  
Denmark



Mr. Jesper Clausen,  
Denmark



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## NDTitans

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Mr. Guy Rapaport,  
Finland



Mr. Nikolaos  
Zoides, Greece



Dr. Thomas  
Callanan, Ireland



Mr. Sal Fasullo,  
Canada



Mr. Oliver Aguirre,  
Mexico



Mr. Hugo D. Orozco,  
Denmark

Next workshop in Europe:

**3<sup>rd</sup> International Educational Workshop on CONCRETE SCIENCE &  
ADVANCED METHODS FOR EVALUATION OF CONCRETE  
with emphasis on deteriorating bridges  
Greece, May 9-12, 2023**

**Same location as the 2<sup>nd</sup> Workshop**