Non-invasive imaging of ancient foundations status in Venice using the Electrical Resistivity Tomography technique

N. Abu-Zeid[1], G. Cocco[2], G. Santarato[1]

[1] Dipartimento di Scienze della Terra, Via Saragat 1, Blocco B, I-44100 Ferrara, Italy
[2] Project and consultant Engineer on behalf of Insula S.p.A., Venice (Italy). Via Marignana 69, Mogliano Veneto (Treviso), Italy

ABSTRACT

Electrical Resistivity Tomography (ERT) is a geophysical method of investigation that has proved to be an outstanding non invasive technique to evaluate the relative degradation state of historical buildings, both under normal dry conditions (e. g.: Cardarelli et al., The Leading Edge, 21, 467-470, 2002) as well as in a much more difficult environment, where materials are saturated with salt water, as is the case of Venice foundations (Abu-Zeid et al., in press on NDT and E Int.).

The reason of its success stems from the fact that highly saline environment doesn't affect neither resolution nor depth of investigation. Modern equipments allow for data to be acquired also under water with a multi-electrode array, which renders the method more attractive. In addition, the availability of powerful inversion software allows to estimate the resistivity model in two (2D) and three (3D) dimensions.

Using a multi-electrode equipment, a 16 m long portion of a canal's wall located at the "Lido" district (Venice, Italy) was investigated. The canal's protection wall consists of two adjacent bricks of about 25 cm total thickness aimed to protect the walls against damage caused by wave action generated by the transport vessels. In this case, the main danger is linked to the formation of voids behind the wall itself, which cannot be seen by the naked eye, nor by other indirect investigation tools such as the GPR technique due to the high energy attenuation due to the presence of salt water. Preliminary results about the foundation conditions were gained by visual inspection. These highlighted that the cement between the bricks was, in some cases, partially or completely absent hence permitting the complete extraction of the brick out of the wall. A closer inspection showed the presence of less compacted materials behind the bricks, which insinuated worries about the resistance of these materials. Based on these preliminary considerations, the consultant asked for the execution of the ERT survey in order to investigate the wall conditions also for the portion under water. The survey was conducted during the maximum tide level. The survey consisted in the execution of 16 vertical profiles each of 3 m long; the electrode spacing was 30 cm. The collected apparent resistivity data were inverted to obtain the best estimated distribution of the resistivity within the wall. The results suggested the presence of highly degraded zones within the first 30 cm of the wall in accordance with the preliminary visual inspection results. The test proved its efficiency in detecting highly degraded zones although immersed in salt water.

Corresponding author: g.santarato@unife.it

Performance of some commercial consolidating agents on porous limestones from Egypt

"Tura and Mokattam quarry"

H. Ahmed[1], Á. Török[2], J. Lőcsei[3]

[1] Helwan University - Academy of Applied Arts, Dept. of Sculpture and Monument Conservation, Orman Giza, Egypt
[2] Budapest University of Technology and Economics, H-1111 Budapest, Stoczek u. 2., Hungary
[3] H-2013 Pomáz, Széchenyi u. 21, Hungary

ABSTRACT

Two types of fresh Egyptian limestones from Mokattam and Tura quarry were used to test the consolidating performace of four different agents on porous limestones. All of these stones were intensively used in the monuments of Ancient Egypt (Sakkara Plateau, Old Cairo City). The fresh quarry samples were consolidated in laboratory conditions by silica-acid-aester, aliphatic-uretan-resin, acrylate resin and Paraloid-72. Before the consolidation and after the treatment the petrophysical parameters of more than 120 cubic samples (5 cm); such as bulk density, ultrasonic sound velocity, real and apparent porosity, Duroscope rebound values were recorded, water absorption by capilary and total immersion for treated and non-treated limestone samples were also compared. Mineralogical composition of non-treated limestone samples were detected by using XRD. The analyses have shown that quarry stones contain salts.

Test results have shown that the Tura limestone can adsorb from 2.90 to 5.60 % of stone consolidant and Mokatam limestone from 5.14 to 9.11%, depending on the Viscosity of the consolidant materials.

The absorption curves of different consolidants for different stone types reflect the differences in pore size distribution and viscosity of conserving agents as well as primary salt content of samples. Duroscope tests have shown that after the first cycle of consolidation there is insignificant change in surface strength of treated specimens compared to the non-treated cubes and is vary from one consolidant to the second.

Corresponding author: torokakos@mail.bme.hu

E. Akatova, L. Laiz, J.M. Gonzalez, C. Saiz-Jimenez

Instituto de Recursos Naturales y Agrobiología, CSIC, Sevilla, Spain

ABSTRACT

The Necrópolis of Carmona (Sevilla, Spain) shows colonization by microbial communities of some of its tombs. Among the microorganisms provoking this biodeterioration, many violaceous spots were found in the Circular Mausoleum. From these spots, a *Streptomyces* sp. was isolated and produced a violet pigment in the culture media. The purpose of this study is to analyze the microbial community associated to the pigment-producing *Streptomyces* and to assess their expansion in the tomb.

Both molecular and culturing techniques were used in order to approach the detection of biodiversity with the functionality of the microorganisms found in these colonies. Molecular methods were based on the detection of microorganisms from DNA and RNA, extracted directly from minute samples collected at the cave and did not require the culture of these microorganisms. Culturing methods required the growth of these microorganisms on previously determined culture media. Media used in this study were appropriated for the growth of aerobic heterotrophs.

Results showed the presence of a large diversity of microorganisms detected from both molecular and culturing methods, and a large proportion of them presented homology to so far uncultured microorganisms. A number of microorganisms were present in these samples, and a fraction of them were metabolically actives suggesting their direct participation in the growth and expansion of the microbial community. Cultures allowed a detailed characterization of the function and capabilities of these microorganisms.

Corresponding author: katren80@yandex.ru

Control of biofilm growth through photodynamic treatments combined with chemical inhibitors: in vitro evaluation methods

H.L. Alakomi[1], A.A. Gorbushina[2], W.E. Krumbein[2], C. McCullagh[1], P. Robertson[3], M. Saarela[1], K. Rodenacker[4]

[1] VTT, Espoo, Finland
[2] ICBM, CvO University Oldenburg, Germany
[3] RGU, Aberdeen, UK
[4]GSF-IBB, Neuherberg, Germany

ABSTRACT

Scientific approaches to the safeguarding of stone monuments have evolved over the years to reach a high level of sophistication. Deeper comprehension of natural biodeterioration processes on stone surfaces has brought about a concept of complex microbial communities, perfectly adapted to rock surfaces growth conditions, and referred to as "subaerial biofilms". The practical implications of biofilm formation are that control strategies must be devised both for testing the susceptibility of the organisms within the biofilm and treating the established biofilm to alter its structure. Effective treatment strategies will incorporate chemical and physical agents that have been demonstrated to penetrate and kill biofilm organisms or treatments that target specific and important components of the biofilm matrix. A better understanding of the in situ biofilm response to selected treatments requires more study and more sophisticated use of biocidal systems.

Also the analysis and the treatment of these detrimental biofilms have made significant progress. A conventional use of single pure cultures as test objects for inhibition tests provides only preliminary information for a treatment. Reactions of controlling agents on harmful subaerial biofilms cannot be faithfully reproduced by single culture test. Cells associated with mineral surfaces and/or growing in biofilms are known to possess significantly different biological properties and are frequently refractory to conventional treatment. For a model biofilm a number of characteristic target species were selected, and their in vitro reactions to the substances in question have been studied.

Another line of evolution of techniques and application proposals is the combined use of biocidal chemicals together with physical activation techniques. The main goal of the study was a clarification of a general reaction of an entire subaerial biofilm system to the treatment suggested. A new testing technique for the integral assessment of a model biofilm formed *in vitro* has been elaborated and tested. A combination of scanning microscopy with image analysis was applied along with traditional cultivation methods and fluorescent activity stains. Such polyphasic approach allows a broad evaluation of the biofilm status and development. Biofilm growth and viability after various treatments is judged by this approach in a quantitative way using chemical, optical and image analysis techniques. An evaluation of the potential success of the newly developed application techniques is given.
This project is funded by the European Community Contract No. EVK4-CT-2002-00098.

Corresponding author: a.gorbushina@uni-oldenburg.de

Physical-mechanical characterization of hydraulic and non-hydraulic lime based mortars for a French porous limestone

M. Al-Mukhtar, K. Beck

Centre de Recherche sur la Matière Divisée, Ecole Polytechnique de l'Université d'Orléans, CNRS-CRMD, 1B rue de la Férollerie 45071 Orléans Cedex 2, France.

ABSTRACT

Sedimentary rocks such as limestone have been commonly used in the construction of several historically important monuments and structures for many centuries in various parts of the world. These structures have an important role towards educating the present and future generations about our human culture, heritage and civilization. However, due to the action of water and the influence of environment, these structures gradually deteriorate over a period of time. Several millions of dollars are annually spent for the maintenance and repairs of these valuable structures in various parts of the world.

There are various construction methods that have been developed based on experience to repair these structures. Investigations indicate clearly that development of suitable repair mortars requires obtaining quantitative technical data about the mechanical, physical and chemical properties of the mortars in addition to a rigorous evaluation process of their performance under real environmental conditions. The analysis of numerous cases of degradation of the heritage architectural monuments in Val de Loire (France) show that the damages often find their origin in the association of mortar – local limestone tuffeau.

This paper examines the mechanical and hydraulic behaviour of the association lime-mortar. Quick and hydraulic lime are used to compose mortars with the aggregates obtained from fragments and\or from powder of the stone tuffeau. Mortars so conceived will have to present similar physico-chemical and hydro-mechanical properties and compatible with those of the tuffeau. This study is interested in the establishment of reliable criteria to estimate the degree of compatibility stone-mortar.

Mechanical performance (compression, tensile and flexion strength) and hydraulic properties (capillary, permeability and water adsorption and desorption) are evaluated for mortar samples composed with different percentages of lime and water. Moreover, mechanical and hydraulic behaviour of sandwich samples (mortar between two pieces of cylindrical samples of stone) are also studied. Adhesion forces of mortar in the sandwich samples are also measured. Finally, in order to study the durability of the stone mortar with the environmental conditions changes, preliminary tests concerning the long term behavior of different samples are also carried out and some of these results will be presented in the conference.

Corresponding author: muzahim@cnrs-orleans.fr

Atmospheric particles in an urban background: damage to building stone

F.J. Alonso[1], F. Díaz-Pache[1,2], C. M. Grossi[1,3] & R.M. Esbert[1]

[1] Dep.de Geología (Petrología y Geoquímica). Universidad de Oviedo. Oviedo (Spain)
[2] Fundación Laboral de la Construcción del Principado de Asturias. Oviedo (Spain)
[3] School of Environmental Sciences, University of East Anglia, NR4 7TJ, UK

ABSTRACT

Different experimental methods were used to collect and analyze atmospheric particles at an urban background site: the Cloister of the Cathedral of Oviedo (Spain). Particles were collected during seven months using a cascade impactor sampler, carbon layers and stone surfaces. SEM-EDX through X-ray mapping and Featurescan –a program for automated particle characterization– were utilized for the morpho-chemical analysis of approximately 6.500 particles, ranging 0.05 – 1000μm. Particles were classified using an exhaustive statistical analysis, which included factor, cluster and discriminant techniques. This classification allowed us to establish main sources of particles and pollution. Fine particles present high sulphur contents and probably come from condensation of atmospheric sulfur dioxide generated by combustion processes. Dust or erosion particles, richer in calcium and silicon, tend to concentrate in coarser fractions. Stone surfaces develop a uniform gypsum coating after only few months of exposure. Results also evidenced a relationship between the type of particles and stone decay, which can be useful when suggesting recommendations for appropriate conservation interventions.

Corresponding author: jalonso@geol.uniovi.es