



# **9<sup>th</sup> EUROSEMINAR ON MICROSCOPY APPLIED TO BUILDING MATERIALS**

9-12 SEPTEMBER 2003, TRONDHEIM, NORWAY

## **PROCEEDINGS**

**EXTENDED ABSTRACTS  
&  
CD-ROM**

Edited by

**M.A.T.M. Broekmans**

**V. Jensen**

**B. Brattli**

### **NOTICE**

The papers contained in this Proceedings volume have been refereed by international peers, and are considered to constitute the latest information available in the relevant fields. However, neither responsibility nor liability is accepted for errors or any consequences arising from the use of information contained herein. Final determination of the suitability of any information, procedure or products, for use contemplated by any user, and the manner of that use, is the sole responsibility of the user. This Proceedings volume is intended as a collection of information only. Expert advice should be obtained at all times with respect to all equipment and procedures when implementation is considered.

### **COPYRIGHT**

By: 9<sup>th</sup> EMABM Organizing Committee © 2003. All rights reserved.  
No part of this publication (book and cd-rom), may be reproduced by any means, or transmitted in any form, without prior written permission from the editors.

### **ADDITIONAL COPIES**

For up to date information on availability, contact the:  
Library of the Geological Survey of Norway (NGU)  
<no P.O. Box>  
N-7491 TRONDHEIM, Norway  
e-mail: [bibliotheket@ngu.no](mailto:bibliotheket@ngu.no)

### **PRINTING**

Grytting A/S  
Postboks 53  
N-7301 ORKANGER, Norway

**ISBN 82-7385-107-9**

## PREFACE

These Proceedings comprise the consolidated contributions to the 9<sup>th</sup> Euroseminar on Microscopy Applied to Building Materials (EMABM), held in the Radisson SAS Royal Garden Hotel in Trondheim, Norway, on September 9-12, 2003.

The Proceedings of this 9<sup>th</sup> EMABM are different in two ways; the one most obvious to the eye being its look-and-feel. Compared to previous editions, you may think of these Proceedings as a 'booklet' rather than a 'volume'. However, this smaller tome with extended abstracts is easier to handle during technical sessions while taking notes than a heavy 500+ page book with full papers. These latter are published on the enclosed CD, are keyword-searchable and printable, and can be studied back home in the convenience of your own office. Second, all of the contributions in these Proceedings have been peer reviewed by a board of preselected reviewers, a prime for the Euroseminar, and adding to its prestige.

A trend towards microscopic techniques other than petrography had already been noticed at the 7<sup>th</sup> EMABM in 1999, which trend now seems to have grown more popular. At this 9<sup>th</sup> EMABM, we see more examples of the miniaturization of initially macro-scale methods, together with the automation and digitization of traditionally analogue technique. This appears to reflect the more general trend in science of improved access to more sophisticated instrumentation, but it also illustrates the awareness of building materials researchers that an interdisciplinary approach is essential to understanding the vast range of mutually interacting processes, mechanisms and building materials, independent of scale.

This is an exciting time to do building materials research, with the emergence of new methods and instrumentation to investigate materials and processes, potentially opening the way for new and refreshing viewpoints on old well-known themes. The editors of Scientific American put it science in general in a wider perspective in their editorial "*In science we trust*" from December 2002 (pg 4):

*"All scientific knowledge is provisional. [...] This is not a weakness of science, this is its glory."*

Be part of the wider perspective! Enjoy the 9<sup>th</sup> Euroseminar, enjoy the Proceedings!

Maarten A.T.M. Broekmans - Chief Editor  
Viggo Jensen  
Bjørge Brattli

**ORGANIZING COMMITTEE**

dr. Viggo Jensen - Chairman

*Norwegian Concrete & Aggregate Laboratory Ltd. (NBTL)*

dr. Maarten A.T.M Broekmans - Secretary

*Geological Survey of Norway (NGU)*

prof.dr. Bjørge Brattli

*Norwegian University of Science & Technology (NTNU)*

mrs. MayKristin Røen MNLA

*Church Council of the City of Bergen (BKF)*

mr. Tor Simensen

*Tvete Arrangement*

**BOARD OF EDITORS**

dr. Maarten A.T.M. Broekmans - Chief Editor

dr. Viggo Jensen

prof.dr. Bjørge Brattli

**BOARD OF REVIEWERS**

<b>Name</b>	<b>Country</b>	<b>Reviews</b>
prof.dr. Bjørge Brattli	Norway	1
dr. Maarten A.T.M. Broekmans	Norway	14
dr. Roland Dreesen	Belgium	4
dr. John Hughes	Scotland	5
dr. Albert Jornet	Switzerland	2
dr. Radko Kühnel	The Netherlands	2
dr. Joe Larbi	The Netherlands	3
Peter Laugesen, MSc	Denmark	1
dr. Sven Lundqvist	Sweden	2
dr. Ted Sibbick	United Kingdom	3
prof.dr. Madalena M.M.S. Teles	Portugal	2
Total papers reviewed:		39
Total pages reviewed:		504

## INTRODUCTION

This Euroseminar on Microscopy Applied to Building Materials (EMABM) is the ninth consecutive in a biennial series, the previous edition in Athens, Greece 2001, September 4-7. This 9<sup>th</sup> EMABM is held in the Radisson SAS Royal Garden Hotel in Trondheim, Norway, on September 9-12, 2003. Its main objective is, and always has been, to promote the use of microscopy as a tool to study building materials, to discuss recent advances, to share views and experiences among experts working with advanced and applied research, and to encourage newcomers in the discipline.

Main themes are microscopy techniques and petrographic analytical methods for the characterization of natural stone and raw materials for building and construction, concrete, masonry, tiles, rendering, repair materials, as well as weathering and deterioration of building materials and structures. The EMABM represents the most important international forum for microscopy and petrography applied to all types of modern and historical building materials.

Another premiere for the EMABM are workshops on specialized themes at the EMABM. The EU-funded PARTNER-project presents results from testing European potentially alkali-reactive aggregates. Two other workshops, chaired by invited internationally renowned experts within each field, deal with technical and organizing issues on 'rehabilitation of historical buildings and materials', and 'sample extraction and preparation for petrographic and geochemical analysis', respectively. Finally, delegates are encouraged to bring their own thin sections and present them for the audience in a two-hour session.

The Organizing Committee of the 9<sup>th</sup> EMABM went through numerous difficulties and adversities arranging this episode but with good will, obstinacy and hard work we hope to have succeeded to make this 9<sup>th</sup> Euroseminar a fruitful experience for all attending. We would like to take the opportunity to thank all of our dedicated and enthusiastic colleagues who have contributed. We also gratefully acknowledge the support from the Geological Survey of Norway (NGU), Norwegian Concrete & Aggregate Laboratory Ltd. (NBTL), Norwegian University for Science & Technology (NTNU), the Church Council of the City of Bergen (BKF), the Restoration Workshop of Nidaros Cathedral (NDR), cement producer NORCEM, Norwegian Zeiss-representative Bergman A/S, Blackwell Publishing, and Trondheim Municipality.

Viggo Jensen, Chairman  
Trondheim, September 2003

## TABLE OF CONTENTS

### Nota Bene!

- The Table of Contents is organized alphabetically by the name of the first author.
- The number of pages ('pp.') refers to the number of A4-format pages of the Full Paper on the included cd-rom, organized in the same way as the Extended abstracts.
- The author presenting the contribution is underlined.

Broekmans, MATM, Jensen, V, and Brattli, B (editors): <i>Preface</i> .	-iii-
Euroseminar Organization	-iv-
Jensen, V (Chairman): <i>Introduction</i> .	-v-
Table of Contents	-vi-

<b>Author (-s), Title</b>	<b>PP.</b>
<u>Alnæs, L</u> , Schouenborg, B, Grelk, B, Brundin, JA, Blasi, P, Yates, T, Marini, P, Tschegg, E, Tokarz, B, Koch, A, Mladenovic, A, and Góralczyk, S: <i>Influence of rock and mineral properties on bowing and strength loss of marble claddings - Discussion paper based on status of work in the TEAM-project.</i>	17
<u>Bonifazi, G</u> , and Castaldi, F: <i>Imaging techniques applied to quality control of concrete materials obtained from the utilization of pre-mixed and ready to use products.</i>	16
<u>Broekmans, MATM</u> : <i>Micro-scale mass-transport sedimentation phenomena reveal the origin of delamination in an industrial floor.</i>	10
<u>Bulteel, D</u> , Degrugilliers, P, Garcia-Diaz, E, and Rafai, N: <i>Petrography study on altered flint aggregate by alkali-silica reaction.</i>	20
<u>Carò, F</u> , and Di Giulio, A: <i>Textural analysis of ancient plasters and mortars: reliability and calibration of an automated image analysis approach.</i>	18
<u>Cnudde, V</u> , Jacobs, P, Vandenabeele, P, and De Witte, I: <i>The potential of X-ray computed micro-tomography applied in conservation and restoration of natural building stones.</i>	7
<u>Crammond, N</u> , Sibbick, T, Collett, C, and Metcalf, D: <i>Thaumasite field trial at Shipston on Stour: three year chemical and mineralogical assessment of buried concrete.</i>	20
<u>Cwirzen, A</u> , and Penttala, V: <i>New approach for prediction of frost damage by means of ESEM/EDS.</i>	17



<b>Author (-s), Title</b>	<b>PP.</b>
<u>Dreesen, R.</u> , and <u>Dusar, M.</u> : <i>An illustrated atlas of the historical building stones in the province of Limburg (NE-Belgium) - role of petrography.</i>	20
<u>Elsen, J.</u> , <u>Brutsaert, A.</u> , <u>Deckers, M.</u> , and <u>Brulet, A.</u> : <i>Microscopical study of ancient mortars from Tournai (Belgium).</i>	10
<u>Fernandes, I.</u> , <u>Noronha, F.</u> , <u>Guedon-Dubied, S.</u> , and <u>Teles, M.</u> : <i>Petrographic analysis of hardened concrete with granitic aggregates.</i>	14
<u>Fernandes, I.</u> , <u>Noronha, F.</u> , and <u>Teles, M.</u> : <i>Microscopical analysis of AAR products in a 50 years old concrete.</i>	13
<u>Fragoulis, D.</u> , <u>Chaniotakis, E.</u> , <u>Stamatakis, M.</u> , and <u>Columbus, G.</u> : <i>Characterization of lightweight aggregates produced with clayey diatomite rocks originated from Greece.</i>	14
<u>Götze, J.</u> , <u>Schreiner, M.</u> , <u>Michalski, S.</u> , and <u>Siedel, H.</u> : <i>Investigation of properties and provenance of ancient building sandstones in Saxony (Germany) by microscopic methods.</i>	12
<u>Gregerová, M.</u> , and <u>Pospíšil, P.</u> : <i>Thaumasite and ettringite formation affected by aggregate and cement composition in concrete.</i>	8
<u>Haugen, M.</u> , <u>Skjølvold, O.</u> , <u>Lindgård, J.</u> , <u>Østnor, T.</u> , and <u>Wigum, BJ.</u> : <i>Experience from petrographic analyses on aggregate separated from concrete cores.</i>	8
<u>Hughes, JJ.</u> , and <u>Trtik, P.</u> : <i>Micro-mechanical properties of cement paste measured by depth sensing nano-indentation: a preliminary correlation of physical properties with phase type.</i>	8
<u>Jakobsen, UH.</u> , <u>Brown, DR.</u> , <u>Comeau, RJ.</u> , and <u>Henriksen, JHH.</u> : <i>Fluorescence epoxy impregnated thin sections prepared for a round Robin test on W/C determination.</i>	11
<u>Jensen, V.</u> : <i>Elgeseter Bridge in Trondheim damaged by alkali-silica reaction: microscopy, expansion and relative humidity measurements, treatment with mono-silanes and repair.</i>	24
<u>Jornet, A.</u> , and <u>Romer, A.</u> : <i>Renovation rendering mortar: comparison between 3 factory-made products.</i>	8
<u>Katayama, T.</u> : <i>How to identify carbonate rock reactions in concrete.</i>	20
<u>Katayama, T.</u> , <u>Tagami, M.</u> , <u>Sarai, Y.</u> , <u>Izumi, S.</u> , <u>Hira, T.</u> , and <u>Nomura, M.</u> : <i>Alkali-aggregate reaction under the influence of deicing salts in the Hokuriku district, Japan.</i>	20
<u>Kolovos, K.</u> , <u>Zafeiropoulos, NE.</u> , and <u>Chalikias, MS.</u> : <i>SEM examinations in mineralized Portland cement clinkers.</i>	13

<b>Author (-s), Title</b>	<b>PP.</b>
<u>Koskiahde, A</u> : <i>An experiential petrographic classification scheme for the condition assessment of concrete in facade panels and balconies.</i>	10
<u>Kühnel, RA</u> : <i>Cause and consequence: volume changes behind building material deterioration.</i>	12
<u>Lagrou, D, Dreesen, R, and Broothaers, L</u> : <i>Comparative quantitative petrographical analysis of Cenozoic aquifer sands in Flanders (N Belgium): overall trends and quality assessment.</i>	13
<u>Leemann, A, and Holzer, L</u> : <i>Alkali-aggregate reaction - identification of reactive silicates.</i>	9
<u>Leslie, AB, and Hughes, JJ</u> : <i>High temperature slag formation in historic Scottish mortars: evidence for production dynamics in 18<sup>th</sup>-19<sup>th</sup> century lime production from Charlestown.</i>	8
<u>Moen, K, Malvik, T, Hjelen, J, and Leinum, JR</u> : <i>Automatic material characterisation by means of SEM-techniques.</i>	8
<u>Nitz, B</u> : <i>Structural analysis of the render of the Bolinder palace in Stockholm.</i>	8
<u>Nixon, P, and Jensen, J</u> : <i>The "PARTNER" project: European standard tests to prevent alkali reactions in aggregates". EU-project: GRD1-CT-2001-40103.</i>	8
<u>Papayianni, I, and Stefanidou, M</u> : <i>Re-crystallization phases in ancient mortars.</i>	5
<u>Papayianni, I, and Stefanidou, M</u> : <i>Xenoliths in the bricks of ancient technology.</i>	7
<u>Sibbick, T, and Crammond, N</u> : <i>The petrographical examination of popcorn calcite deposition (PCD) within concrete mortar, and its association with other forms of degradation.</i>	19
<u>Storemyr, P</u> : <i>Weathering of soapstone in a historical perspective.</i>	21
<u>Sutter, LL, Peterson, KR, and Van Dam, TJ</u> : <i>The X-ray microscope: a new tool for measuring the density of hardened concrete.</i>	9
<u>Walsh, JA</u> : <i>The relationship between the cleavage properties of natural roofing slate and the thickness of the finished material.</i>	16
<u>Wigum, BJ, Haugen, M, Skjølsvold, O, and Lindgård, J</u> : <i>Accuracy of the Norwegian petrographic method to quantify alkali reactive rock types in aggregates.</i>	14
<u>Wong, CH, Chen, HF, and Tay, YPK</u> : <i>Diagnosing tiling failures with the aid of microscopic and macroscopic examination.</i>	10
Total pages:	505