Concrete and Radiological Aspects

DTU-COST-RILEM Doctoral Course
Technical University of Denmark
Lyngby, Denmark
August 15-19, 2016

Organized by
Ole Mejlhede Jensen, Technical University of Denmark
Zoltán Sas, Queen’s University Belfast, United Kingdom
Wouter Schroeyers, UHasselt, Belgium

Sponsored by
Knud Højgaards Fond
Ingeborg og Leo Dannins Legat for Videnskabelig Forskning
Larsen & Nielsen Fonden
PROGRAM

Concrete and Radiological Aspects

DTU-COST-RILEM Doctoral Course
Technical University of Denmark
Department of Civil Engineering
Lyngby, August 15-19, 2016

Place
All lectures will be given at the Technical University of Denmark, in the main meeting center of Building 101, room S09 – use entrance A, go to the right. Meeting places for other activities may be different, please refer to the detailed description for each module. You can find directions for DTU and a map of the university campus through http://www.dtu.dk/english/About/CAMPUSES/DTU-LYNGBY-Campus

For travel from the airport to the Technical University of Denmark the recommended route is to take the metro from airport terminal 3 to Nørreport train station (departure approx. every 5 min). Change to bus 150S (departure every 10 min on weekdays, every 20 min on Saturday and Sunday). The bus stops on the motorway right next to the Technical University of Denmark. Locations of bus stops are shown at the map further in this program.

Travel, meals, and accommodation
Course attendees are responsible for travel, meals and accommodation. A student canteen is located in Building 101 on campus. Evening meals on Monday and Thursday are included in the course fee.
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Time schedule
The time schedule is given in the overview program below and it is detailed out in the description of each individual module. At the start of the course, the participants will be divided into groups. This division is relevant for participation in the late afternoon labs and the participant presentations; cf. the overview program.

Preparations
Please carefully observe the requested preparations given in the detailed description for each module. In particular, please observe the preparations needed for Module 1. Preparatory readings are available through the site share.dtu.dk which course participants have access to. This site will be used for both download and upload of material before and during the course.

If possible, bring a laptop with you – it will be very useful during many of the activities – and a hand-held calculator may also be relevant during e.g. lab work. The location is covered by a wireless network. Participants coming from research and education institutions almost anywhere in the world will be able to obtain Internet connectivity across the DTU campus through the Eduroam system. To take advantage of this you need to establish the Eduroam connection at your home institution before arriving at DTU. When properly installed you will subsequently need no special log-in or set-up when accessing the wireless network at DTU; your computer will have internet access just like if you were at your home institution. It is highly recommended that participants make arrangements for an Eduroam connection before leaving their home institution.

Teachers
Stéphanie Staquet, Building, Architecture & Town Planning, Université Libre de Bruxelles, Bruxelles, Belgium, sstaquet@ulb.ac.be
Miguel Azenha, Department of Civil Engineering, University of Minho, Guimarães, Portugal, Miguel.azenha@civil.uminho.pt
Ole Mejlhede Jensen, Construction Materials Section, Department of Civil Engineering, Technical University of Denmark, Lyngby, Denmark, omj@byg.dtu.dk
Konstantin Kovler, National Building Research Institute, Faculty of Civil and Environmental Engineering, Technion – Israel Institute of Technology, Haifa, Israel, cvrkost@technion.ac.il
Zoltán Sas, Queen’s University Belfast, United Kingdom, ilozas@gmail.com
Wouter Schroeyers, Hasselt University, Belgium, wouter.schroeyers@uhasselt.be
Participants
A participant list is given below. The participants are divided into groups for the lab work and for the participant presentations – see modules 4, 9, 19 and 20.

<table>
<thead>
<tr>
<th>1st name</th>
<th>Surname</th>
<th>Institution</th>
<th>Email</th>
<th>Group</th>
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<tbody>
<tr>
<td>Andras</td>
<td>Bednar</td>
<td>University of Panonnia</td>
<td><a href="mailto:bm.abednar@gmail.com">bm.abednar@gmail.com</a></td>
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<tr>
<td>Francis</td>
<td>Gyakwaa</td>
<td>University of Tartu</td>
<td><a href="mailto:gyakwaa@ut.ee">gyakwaa@ut.ee</a></td>
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<tr>
<td>Mirela</td>
<td>Alushllari</td>
<td>University of Tirana</td>
<td><a href="mailto:m.alushllari@gmail.com">m.alushllari@gmail.com</a></td>
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<tr>
<td>Susanne</td>
<td>Friedreich</td>
<td>Ages, Austrian Agency for Health and Food Safety, Austria</td>
<td><a href="mailto:susanne.friedreich@ages.at">susanne.friedreich@ages.at</a></td>
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<tr>
<td>Viktoria</td>
<td>Schauer</td>
<td>Ages, Austrian Agency for Health and Food Safety, Austria</td>
<td><a href="mailto:viktoria_schauer@yahoo.de">viktoria_schauer@yahoo.de</a></td>
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<tr>
<td>Silvana</td>
<td>Beltran</td>
<td>University of Budapest</td>
<td><a href="mailto:silvanybel@gmail.com">silvanybel@gmail.com</a></td>
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Insurance
For your stay you should consider to take out an insurance policy to cover for example your personal valuables and to compensate you in case of an accident. The course organization and DTU do not include this kind of coverage. We will do our best to help you protecting yourself and your valuables, but we cannot take any responsibility.

Certificates
Certificates certifying the completion of the course will be issued and 5 ECTS points will be granted to participants who have attended and finalized all course activities. For participation in parts of the course a lower amount of ECTS points will be granted.

Forms to fill in
In this detailed program you will find a number of forms you should fill in before, during and at the end of the course:

- **RILEM free membership**
  Participating PhD-students are granted a 3-year free membership of the scientific organization RILEM. If you would like to take advantage of this offer you need to fill in the form, and give it to the course organizers before end of the course. Read more about RILEM at: [www.RILEM.net](http://www.RILEM.net)

- **Poster competition**
  During the course – in breaks or at the end of the day – you should study the posters by other course participants. You may discuss elements in each poster with the author. All posters will enter a prize competition and your vote is included in the decision. You need to fill in the form and hand it over to the course organizers.

- **Course Evaluation**
  Your evaluation of the course is appreciated. It is very useful information for the course organizers to improve subsequent courses and it helps lecturers to improve their teaching. Please fill in the form and hand it over to the course organizers at end of the course.
Concrete and Radiological Aspects
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Map of DTU

Legend
- Departments
- Discos Hall
- Administration
- Campus Service
- Residential halls and guest houses
- Scan DTU
- Instructional buildings
- Bus stops
- Canteens
- DTU Library
- DTU Meeting Centre

Building 117
Lab exercise Modules 4&5

Canteen

Bus 150S - from Nørreport Station

Bus 150S - to Nørreport Station

Lectures, DTU meeting center
## Course Overview Program

**Overview program, DTU-RILEM Doctoral Course**  
**Concrete and Radiological Aspects**  
Technical University of Denmark, Lyngby, Denmark, 15-19 August 2016  
Organized by: Ole Mejlhede Jensen, Zoltán Sas and Wouter Schroeyers

<table>
<thead>
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<th>Tuesday 16</th>
<th>Wednesday 17</th>
<th>Thursday 18</th>
<th>Friday 19</th>
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<tbody>
<tr>
<td>8:00</td>
<td>6. Autogenous deformation Lecture (omj)</td>
<td>10. Introduction NORM &amp; Construction Lecture (wsc)</td>
<td>14. Radon emanation and exhalation Practical exercise (zsa)</td>
<td>19. Preparation of participant presentations (omj)</td>
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<td>9:00</td>
<td>Coffee</td>
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<td>17:00</td>
<td>Lunch</td>
<td>Jury meeting</td>
<td>Closure</td>
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<td>18:00</td>
<td>Barbecue</td>
<td>18. Course dinner</td>
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</table>

Module responsible: Miguel Azenha (maz), Jose Oranje (jlg), Ole Mejlhede Jensen (omj), Konstantin Kovler (kko), Zoltán Sas (zsa), Wouter Schroeyers (wsc), Stéphanie Stappe (sst)  
Rev. 30.8.16
Module 1

Monday 15 August, 8:30 - 10:15

Introduction to course and presentation of participants
Module responsible: Ole Mejhlhede Jensen, Technical University of Denmark
All teachers are involved in this module

Objective
The objective is to familiarize participants and teachers with each other and to introduce the participants to the course contents. Participants will be practiced in giving a short oral presentation of themselves and their research topic.

Topics
The course curriculum and the teachers will be presented. The participants will be given a short introduction to RILEM and COST TU1404. The participants will present themselves and their research and participant posters will be put on display.

Preparations
Before the course you need to finalize the following:

1) You need to bring a printed poster, size A1 in portrait layout, with you for the course. The poster should – in English – present your research project or your research interest to the teachers and to the rest of the participants. Posters will during the course enter a prize competition. You will not be asked to make an oral presentation of the poster but of course you might be asked questions from the interested teachers and other course participants during the breaks. Your poster may show finalized results, or it may be a description of research you plan to do. The research may be from your PhD-project or from another project you have accomplished or you are involved in – it is entirely up to you.

2) You also need to make a presentation of yourself during the course introduction module: Where do you come from?, what is your background?, what is your main research topic?. For this purpose you need to make a PowerPoint presentation consisting of ONE single slide, and for your oral presentation of this slide you have ONE minute available. Consider carefully not overfilling your slide or your oral presentation with information, and keep strictly within the given limits – we have a tight schedule!

3) Read the preparatory readings listed for each module (downloadable from share.dtu.dk).

4) At latest on August 10th you need to upload the PowerPoint presentation slide (format: ppt) and the poster (format: pdf) in electronic form to the share.dtu.dk site. Limit the size of each of these files to a maximum of 1 Mb, and use the file name structure “presentation-[surname]-[1stname].ppt” and “poster-[surname]-[1stname].pdf” respectively.
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Module 2
Monday 15 August, 1045 - 1230

Cements: historical development, manufacture, composition and properties
Konstantin Kovler, Technion – Israel Institute of Technology

Objective
To introduce the participants with historical development of cementitious materials, manufacture of portland cement, its composition and properties.

Topics
The following topics will be addressed during the presentation:
History of cementitious materials from the ancient times to the XXI century; manufacture of portland cement; chemical and mineralogical composition of portland cement; types of portland cement; properties and testing of portland cement.

Written exercise
The exercises are aimed (1) to identify the type of portland cement using the chemical analysis and Bogue's equations and (2) to calculate the content of some mineral phases using the data of physical-chemical tests of cement.

Preparatory reading
The following paper should be read before the lecture (homework):
Concrete and Radiological Aspects
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Module 3  Monday 15 August, 13:30 - 15:15

Lab preparation lecture
Miguel Azenha, University of Minho
Stéphanie Staquet, Université Libre de Bruxelles

Competence targets
The objective of the lecture is to provide in-depth information about operational aspects related to the Lab lecture.

Topics
The following topics will be addressed during the presentation:
- Overall discussion of the objectives. Explanation of the mortar mixes to be tested.
- Specific aspects for the necessary techniques during the Lab:
  - Mixing and casting. Thermocouples and data logging. EMM-ARM, accelerometers (measurement and data logging). Autogenous deformation (ASTM C-1698). Ring test and strain measurement (ASTM C1581-04). Ultrasound Pulse Velocity measurement. Resistivity. Complementary information on compressive strength, tensile strength and static E-modulus (previously tested by the teaching staff).

Operational aspects for preparation of the lab:
- Gathering participants into groups of 5 and establishing roles.
- Explanation of roles of participants in both Lab A (Monday) and Lab B (Tuesday).
- Detailed discussion of the planning of operations (people + schedule).

Preparatory reading
The following material should be read before the lecture (homework) – these papers are joint readings also for modules 4, 9 and 16:


**Heat release:** Quasi-adiabatic calorimetry for concretes, Influential factors, Claude Boulay et al, BLPC 278 (October-November 2010) 19-36.

**Ultrasound wave’s transmission:** Monitoring the setting process of mortars by ultrasonic P and S-wave transmission velocity measurement, Jérôme Carette, Stéphanie Staquet, Construction & Building Materials 94 (2015) 196-208.

**Dielectric properties:** Dielectric Characterization of Young Concrete, Beek A. van, Hilhorst M.A., Heron 44 (1) (1999) 3-17.


Lab exercise Part A
Stéphanie Staquet, Université Libre de Bruxelles
Miguel Azenha, University of Minho
All teachers are involved in this module

Competence targets
The objective of the lab exercise is to study the evolution of the early age properties of mortar made at normal and low water to cementitious materials ratios, with and without mineral additive like limestone filler, under sealed and drying conditions and under free and restraint deformations to have an in-depth knowledge and practice of advanced non-destructive testing methods for early age monitoring.

Topics
The following advanced non-destructive testing methods will be used during the lab exercise to monitor the early age properties of three different mortars:

- EMM-ARM, accelerometers (measurement and data logging);
- Thermocouples and data logging;
- Ultrasound Pulse Velocity measurement;
- Resistivity;
- Autogenous deformation (ASTM C-1698);
- Ring test and strain measurement (ASTM C1581-04).

Preparatory reading
The following material should be read:

The same set of 6 papers given in the module 3 description.
Barbecue
Ole Mejlhede Jensen, Technical University of Denmark

Invitation
You are invited to come and enjoy a nice summer evening barbecue together with other course participants and teachers. The meal and drinks are included in the course fee.

Place
In the patio, outside the big canteen, building 101. In case of rain we will be indoor in the big canteen.

Preparations
If the weather allows us, we will be sitting outdoors. In the evening it may be chilly - bring a jacket with you.
Autogenous deformation
Ole Mejlhede Jensen, Technical University of Denmark

Objective
The objective of the lecture is to give the participants an introduction to the phenomena of autogenous deformation in hardening cementitious systems.

Topics
The following topics will be addressed during the presentation:
- Modern concretes. Terminology.
- Volume relations. The Kelvin equation.
- Shrinkage mechanisms. Deformation measurement.
- Tensile strain capacity. Relative humidity measurement.
- Cement hydration at reduced RH. Clinker mineral and silica fume reactions at reduced RH.
- Chemical shrinkage and pore structure due to silica fume.
- Internal water curing.
- Lightweight aggregate.
- Super-absorbent polymers.
- Autogenous relative humidity.
- Autogenous strain.
- Stress development.

Preparatory reading
The following papers should be read before the lecture (homework):


Elastic properties
José Granja, University of Minho
Miguel Azenha, University of Minho

Competence targets
The objective of the lecture is to give the participants in-depth knowledge about the relevant phenomena related to the elastic behavior of cement based materials, as well as the experimental approaches to assess elastic properties.

Topics
The following topics will be addressed during the presentation:

Elastic behavior
What is an ‘elastic property’? Microstructural features related to the elastic behavior. Quasi-static and dynamic elastic moduli. Structural setting. Percolation threshold.

Experimental techniques
Cyclic compression testing. Ultrasound pulse velocity methods. Automated cyclic tests (e.g. TSTM, BTJASPE). Resonant frequency methods (classic and EMM-ARM). Smart aggregates. Other approaches.

Preparatory reading
The following papers should be read before the lecture (homework):


Creep and relaxation
Stéphanie Staquet, Université Libre de Bruxelles

Competence targets
The objective of the lecture is to give the participants in-depth knowledge about the relevant phenomena related to the creep and relaxation of cement based materials including the existing modeling approaches as well as experimental approaches to assess creep and relaxation.

Topics
The following topics will be addressed during the presentation:

Creep and relaxation
What is a ‘time-dependent property’? Microstructural features related to the creep and relaxation behavior. Rheological modeling. Influence of various parameters on creep like the stress level, the age at loading, the direction of loading in tension or in compression. Recovery phenomenon. Variable temperature histories.

Experimental techniques
Cyclic testing in tension and in compression. Long lasting testing. Automated cyclic tests (e.g. TSTM, BTJASPE). Longitudinal and lateral displacements monitoring. Other approaches.

Preparatory reading
The following papers should be read before the lecture (homework):

‘Concrete early age basic creep: Experiments and test of rheological modelling approaches’

‘Early age creep and relaxation modelling of concrete under tension and compression’
Module 9
Tuesday 16 August, 15:45 - 17:30

Lab exercise Part B
Module responsible: Stéphanie Staquet, Université Libre de Bruxelles
Miguel Azenha, University of Minho
All teachers are involved in this module

Competence targets
Information will follow.
Introduction NORM & Construction
Wouter Schroeyers, UHasselt, Belgium

Objective
This lecture intends to introduce NORM, the NORM processing industries and reuse of NORM residues in construction. An important goal is to generate discussion regarding the reuse of NORM residues in construction materials and to discuss the impact of the new European basic safety standards (EU-BSS) on the NORM processing industry.

Topics
This lecture deals with the different NORM processing industries using several cases as an examples, A lot of focus will go to the (re)use of NORM in construction materials and the new EU-BSS.

Preparatory reading
The following material should be read before the lecture (homework):

Module 11  Wednesday 17 August, 10:45 - 12:30

Sampling & measurement challenges for NORM & NORM containing construction materials
Wouter Schroeyers, UHasselt, Belgium

Objective
This lecture intends to introduce the problems regarding the sampling and characterisation of NORM & NORM containing construction materials.

Topics
This lecture deals with sampling strategies, characterisation problems for NORM and NORM containing construction materials.

Preparatory reading
The following material should be read before the lecture (homework):

Dose of workers in workplaces originated NORM under indoor and outdoor circumstances
Zoltán Sas, Queens University Belfast

Objective
This lecture intends to introduce case studies carried out in workplaces and industrial waste product depositories.

Topics
This lecture deals with case studies about the issues of NORMs in the case of workplaces e.g. mines, caves, spas, processing industry, by-product depositories.

Preparatory reading
The following material should be read before the lecture (homework):


Module 13 Wednesday 17 August, 15:45 - 17:30

External gamma dose assessment from building materials according to IAEA SSG-32
Zoltán Sas, Queens University Belfast

Objective
This practical exercise intends to introduce an easy dose calculation originated from external gamma radiation from construction materials. This allows the most typical dose assessments to be made without computer calculations.

Topics
The major contributions to the dose from exposure to gamma radiation from building materials are from $^{226}\text{Ra}$ and $^{232}\text{Th}$ and their progeny, and $^{40}\text{K}$. The dose calculation method is based on calculating the dose rate for a rectangular building constructed of building material of uniform density and containing radionuclides of uniform activity concentration. The dose rate indoors is calculated by summing the separately calculated dose rates due to radionuclides in the walls, floor and ceiling of a room. The calculation covers situations in which the radionuclides are distributed in two layers of separate building materials with different densities and activity concentrations; for example, concrete walls covered with a thin layer of another material such as tiles.

Preparatory reading
The following material should be read before the exercise (homework):

Protection of the Public against Exposure Indoors due to Radon and Other Natural Sources of Radiation, IAEA Safety Standards Series No. SSG-32
Radon emanation and exhalation influencing parameters; Radon measurement techniques; determination of radon emanation and exhalation I
Zoltán Sas, Queens University Belfast

Objective
This lecture / practical exercise introduces the phenomena of radon emanation and exhalation, and the most relevant influencing effects

Topics
General introduction of radon emanation and its influencing parameters.
Radon transport in the material matrix
Exhalation phenomena and influencing parameters
Introduction of common radon measuring devices and methods (passive and active measurement techniques)
Comparison of measurement techniques, selection criteria
Case study I: radon emanation end exhalation of NORM by-products (Metallurgical slag, Fly ash, Bottom ash, red mud)
Case study II: radon exhalation reduction in the case of clayish materials

Preparatory reading
The following material should be read before the lecture / exercise (homework):


‘Protection of the Public against Exposure Indoors due to Radon and Other Natural Sources of Radiation, IAEA Safety Standards Series No. SSG-32’ International Atomic Energy Agency, Vienna (2003) (Also listed as Module 13 reading)
Module 15

Thursday 18 August, 10:45 - 12:30

Radon emanation and exhalation influencing parameters; Radon measurement techniques; determination of radon emanation and exhalation II
Zoltán Sas, Queens University Belfast

Continuation of module 14.
Lab Part A & Part B written exercise
Stéphanie Staquet, Université Libre de Bruxelles
Miguel Azenha, University of Minho
Brice Delsaute, Université Libre de Bruxelles

Competence targets
This written exercise intends to provide in-depth understanding and comparison into detail of the evolution of the early age properties of the three mortar mixes having been casted during Modules 4 & 9 by the participants, typically:
- a Portland cement mortar mix with w/c ratio of 0.4 (the modified Vercors mortar proposed in the RRT+ of COST Action TU1404);
- a Portland cement mortar mix with w/c ratio of 0.3 (low water/cement ratio);
- a Portland cement mortar mix with w/c ratio of 0.4 where 25% of cement has been substituted by limestone filler (water/(cement+filler) ratio of 0.3).

Written exercise
The experimental results obtained during Modules 4 & 9 by the participants will be discussed and analyzed into details for each of these following advanced non-destructive testing methods to highlight the effect of the water/cement ratio and the partial substitution of Portland cement by limestone filler:

- EMM-ARM, accelerometers (measurement and data logging): Young’s modulus;
- Thermocouples and data logging: heat release during hydration;
- Ultrasound Pulse Velocity measurement: dynamic elastic properties and setting;
- Resistivity: strength evolution;
- Autogenous deformation (ASTM C-1698): autogenous shrinkage;
- Ring test and strain measurement (ASTM C1581-04): restraint shrinkage and age at cracking.

In addition to these analyzes made for each testing method independently, comparisons and correlations will also been discussed between the different properties for each mortar: strength versus Young’s modulus, autogenous shrinkage and setting versus heat release, restraint shrinkage.

Preparatory reading
The following material should be read before the lab exercise (homework):

The same set of 6 papers given in the module 3 description.
Study tour
Ole Mejlhede Jensen, Technical University of Denmark

Objective
The objective of the tour is to let the participants gain the impression of challenges and possibilities experienced at a construction site. We will visit a construction site in the greater Copenhagen area by bus. Our host will be the contractor, MT Højgaard. With more than 5,000 employees and yearly sales over EUR 1.000 million, MT Højgaard is the largest Danish contractor. The founder of MT Højgaard, the late Mr. Knud Højgaard, is a very significant sponsor of this doctoral course greatly subsidizing the costs through the Knud Højgaard Foundation.

Preliminary program
Details, including the specific site to be visited, will be decided shortly before the course.

15:45  Bus leaves from DTU, building 101

16:00  Arrival at the construction site. Presentation of the construction site by Mr. Esper Christophersen, Vice President for Civil Works & Concrete production, MTHøjgaard.

17:45  Exit of the construction site. From there we will drive by bus back to DTU for dinner.

Preparations
Bring suitable clothes and in particular suitable footwear. The construction site visit will for a major part be outdoors. Due to the nature of the construction site safety shoes, hard hat and special clothes are not needed.
Course dinner
Ole Mejlvæde Jensen, Technical University of Denmark

Invitation
You are invited to come and enjoy a summer evening dinner at DTU together with other course participants and teachers. The evening meal is included in the course fee.

We will travel to the dinner together by bus – directly from the study tour.
Module 19

Friday 19 August, 8\textsuperscript{30} - 12\textsuperscript{30}

Preparation of participant presentations

Module responsible: Ole Mejlhede Jensen, Technical University of Denmark
All teachers are involved in this module

Competence targets
The objective of the module is to practice the participants in preparing an oral, scientific presentation through group work.

Format
Each group needs to prepare a 12 minute – be exact! – “conference presentation”. The presentation should involve experimental results from the lab modules, data analysis, a relevant discussion and conclusions. Knowledge gained through the teaching modules and the preparatory readings, and perhaps observations from the study tour may be incorporated in the presentation. The topic for the presentation is free, within the theme of the course. Considering the length of the presentation it will not be suitable to present all lab results – rather pick out some and make a common thread in your presentation. Due to the limited time in the preparation module you need to organize your group work well both before and during the module.

Preparations
It is necessary that each course participant in advance, individually prepare as well as possible for this module. This includes making a preliminary analysis of the results in the spare time – Tuesday and Wednesday evenings – and within each group, during the breaks, to coordinate who should prepare what tasks for this module. In any case bring along your own laptop with your favorite programs installed for data analysis and visualization. This will enable you more quickly and easily to contribute to the group work. To focus the time of the group on the contents of the presentation, perhaps you have also prepared a PowerPoint slide design that you can bring with you to be used for the presentation.
Module 20 Friday 19 August, 13:30 - 17:30

Participant presentations
Module responsible: Ole Mejlhede Jensen, Technical University of Denmark
All teachers are involved in this module

Competence targets
The objective of the module is to practice the participants in giving an oral, scientific presentation and to comment on presentations by others.

Format
Each group needs to give a 12 minute “conference presentation”. Each group presentation will subsequently be discussed in plenum where all course participants are expected to be involved. It is important that the time slot for the group presentation is properly filled out and that the time is not overrun. A PowerPoint projector will be available for the presentation.

After the final presentation a short summary of the course will be given and to further develop the Doctoral Course concept, the participants are kindly asked to comment on the course.
RILEM Technical Committees, August 2016

TC No. and acronym TC title (Chair)
ASC: Accelerated lab. test for the assessment of the durab. of mater. with respect to salt crystallization (Barbara LUBELLI)
CHA: Crack-Healing of Asphalt Pavement Materials (Hassan BAAJ)
CIM: Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice (Eddie A. B. KOENDERS)
DFC: Digital fabrication with cement-based materials (Nicolas ROUSSEL)
HDB: Hygrothermal behaviour and Durability of Bio-aggregate based building materials (Sofiane AMZIANE)
IAM: Damage assessm., Rep./ Retrofit-Recov. in Concr. & Masonry Struct. by Means of Innov. NDT (Tomoki SHIOTANI)
MRP: Measuring Rheological Properties of Cement-based Materials (Mohammed SONEBI)
PIM: Phase and Interphase behaviour of bituminous Materials (Emmanuel CHAILLEUX)
RAC: Structural behaviour and innovation of recycled aggregate concrete (Jianzhuang XIAO)
SHE: Self-healing concrete – Its efficiency and evaluation (Feng XING)
SIF: Surface delamination of concrete industrial floors (Valérie POLLET)
TC: Testing and characterisation of earth-based building materials and elements (Jean-Claude MOREL)
TRM: Tests for reactivity of supplementary cementitious materials (Karen SCRIVENER)
235-CTC: Corrosion initiating chloride threshold concentrations in concrete (Luping TANG)
236-BBM: Bio-aggregates based building materials (Sofiane AMZIANE)
237-SIB: Testing and characterization of sustainable innovative bituminous materials and systems (Manfred N. PARTL)
238-SCM: Hydration and microstructure of concrete with supplementary cementitious materials (Nele DE BELIE)
240-FDS: A framework for durab. design of fibre-reinf. strain-harden. Cem.-based composites (Gideon VAN ZIJL)
241-MCD: Mechanisms of Cracking and Debonding in Asphalt and Composite Pavements (William G. BUTTLAR)
243-SGM: Specifications for non-structural grouting of historic masonries and architectural surfaces (Caspar J.w.p. GROOT)
244-NUM: Numerical modelling of cement-based materials (Klaas VAN BREUGEL)
245-RTE: Reinforcement of Timber Elements in Existing Structures (Jorge BRANCO)
246-TDC: Test methods to determine durab. of concrete under combined environm. actions and mechanical load (Yan YAO)
247-DTA: Durability testing of alkali-activated materials (John L. PROVIS)
248-MMB: Methods of measuring moisture in building materials and structures (Lars-Olof NILSSON)
249-MSC: Non destructive in situ strength assessment of concrete (Dennis BREYSSE)
250-CMB: Chemo-Mechanical Characterization of Bituminous Materials (Nicole KRINGOS)
253-MCI: Microorganisms-cementitious materials interaction (Alexandra BERTRON)
254-CMS: Thermal cracking of massive concrete structures (Eduardo M.r. FAIRBAIRN)
255-FRS: Fire resistance of concrete structures repaired with polymer cement mortar (Takahumi NOGUCHI)
256-SPF: Spalling of concrete due to fire: testing and modelling (Pierre PIMIENTA)
258-AAA: Avoiding alkali aggregate reactions in concrete - Performance based concept (Børge Johannes WIGUM)
259-ISR: Prognosis of deterior. and loss of serviceability in struct. affected by alkali-silica reactions (Victor E. SAOUMA)
260-RSC: Recommendations for use of superabsorbent polymers in concrete construction (Viktor MECHTCHERINE)
261-CFC: Creep behavior in Cracked Sections of Fiber Reinforced Concrete (Pedro SERNA ROS)
262-SCI: Characteristics of the steel/concr. interf. and their effect on initiat. of chloride-induced reinf. corrs. (Ueli ANGST)
263-EEC: Environmental evaluation of concrete structures toward sustainable construction (Ammon KATZ)
264-RAP: Asphalt Pavement Recycling (Gabriele TEBALDI)

You can see details about RILEM and its Committees at the RILEM home page: www.RILEM.net

PhD-students participating in the doctoral course are granted a 3-year free membership of RILEM. This will be arranged by the course organizers subsequent to your return of this form.

1. Are you PhD-student? – please circle: YES NO
2. Print your name in block capital letters:
3. In the above list please circle one or two TCs of which you have interest in their work. The RILEM general secretariat will subsequently arrange that you become member of these TCs.
4. Give this form to the course organizers before end of the course.
Poster Competition Form

During the course – in breaks or at the end of the day – you should study the posters by other course participants. You may discuss elements in each poster with the author. All posters will enter a prize competition which is handled by a jury of course teachers, but your vote is included in the decision. For this purpose you need to fill in this form and hand it over to the course organizers.

Elements you might take into consideration for your vote are:
- the “format” of the poster, i.e. how well the poster presents its contents. Is the poster logically structured, is there a relevant use of graphs and photos, is there an appropriate amount of information on the available space, is the poster easy to read, is the layout clean?, etc.
- the “technical content” of the poster, i.e. the quality of the scientific elements in the poster. Is the research idea interesting and relevant, are the materials and methods well-chosen and described, are the results properly analysed, are the conclusions appropriately based on the contents of the research?, etc.

In your evaluation you can weigh the above elements as you like in order to reach your decision of how you rank each poster. Below please fill in the reference numbers of the posters you think perform the best. If you feel your own poster ranks among these you should include it. You need to fill in exactly 5 different poster reference numbers – failing to do so will make your vote not valid. Only one form is to be filled in by each participant.

Best poster: □

2nd best poster: □

3rd best poster: □

4th best poster: □

5th best poster: □
Course Evaluation Form

The following pages is a form for your evaluation of the course.

You may find it convenient to fill in your evaluation after you have been through the full course, or you may prefer to do it after every module; the modules are listed consecutively in the following. We appreciate your frank and constructive opinion as it is very useful information for the course organizers to improve subsequent courses and it helps lecturers to improve their teaching.

At the end of the course you can hand over the form anonymously to the course organizers – a box will be set up for this purpose. Please keep the pages of your form together when you return it at the end of the course – keep the staple in the corner. This makes our handling of the responses easier.

GENERAL COMMENTS TO THE COURSE:

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## Module 1: Introduction to course and presentation of participants

**How useful was this module?**
- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments: __________________________________________________________

____________________________________________________________________

## Module 2: Cement and binders Lecture

**How useful was this module?**
- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments: __________________________________________________________

____________________________________________________________________

## Module 3: Lab preparations Lecture

**How useful was this module?**
- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments: __________________________________________________________

____________________________________________________________________

## Module 4: Lab exercise Part A

**How useful was this module?**
- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments: __________________________________________________________

____________________________________________________________________

## Module 5: Barbecue

**How useful was this module?**
- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments: __________________________________________________________

____________________________________________________________________
**Concrete and Radiological Aspects**
DTU-COST-RILEM Doctoral Course, Technical University of Denmark, August 15-19, 2016
Organized by Ole Mejlhede Jensen, Zoltán Sas and Wouter Schroeyers

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**Module 6: Autogenous deformation**

<table>
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<th>well</th>
<th>very well</th>
</tr>
</thead>
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Comments: ________________________________________________________

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**Module 7: Elastic properties Lecture**

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Comments: ________________________________________________________

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**Module 8: Creep and relaxation Lecture**

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Comments: ________________________________________________________

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**Module 9: Lab exercise Part B**

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Comments: ________________________________________________________
Module 10:
How useful was this module?

[ ] unsatisfactory  [ ] bad  [ ] satisfactory  [ ] well  [ ] very well

Comments: ____________________________________________________________

Module 11:
How useful was this module?

[ ] unsatisfactory  [ ] bad  [ ] satisfactory  [ ] well  [ ] very well

Comments: ____________________________________________________________

Module 12:
How useful was this module?

[ ] unsatisfactory  [ ] bad  [ ] satisfactory  [ ] well  [ ] very well

Comments: ____________________________________________________________

Module 13:
How useful was this module?

[ ] unsatisfactory  [ ] bad  [ ] satisfactory  [ ] well  [ ] very well

Comments: ____________________________________________________________
Module 14:
How useful was this module?

- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments:__________________________________________________________________
___________________________________________________________________________

Module 15:
How useful was this module?

- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments:__________________________________________________________________
___________________________________________________________________________

Module 16: Lab A&B written exercise
How useful was this module?

- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments:__________________________________________________________________
___________________________________________________________________________

Module 17: Study tour
How useful was this module?

- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments:__________________________________________________________________
___________________________________________________________________________

Module 18: Course dinner
How useful was this module?

- [ ] unsatisfactory
- [ ] bad
- [ ] satisfactory
- [ ] well
- [ ] very well

Comments:__________________________________________________________________
___________________________________________________________________________
Module 19: Preparation of participant presentations

How useful was this module? □ unsatisfactory  □ bad  □ satisfactory  □ well  □ very well

Comments:__________________________________________________________________
___________________________________________________________________________

Module 20: Participant presentations

How useful was this module? □ unsatisfactory  □ bad  □ satisfactory  □ well  □ very well

Comments:__________________________________________________________________
___________________________________________________________________________
Concrete and Radiological Aspects
DTU-COST-RILEM Doctoral Course, Technical University of Denmark, August 15-19, 2016