

MMC

RILEM EAC Course

Delft University of Technology
Tecnalia, Spain

Organized by:
Delft University of Technology
Delft, The Netherlands



Multi-scale Modeling Course for Concrete

Delft University of Technology
November, 2013





Course objective: Multi-scale Modelling Course for Concrete (MMC²)

Each year the MMC course is co-organized as a joint event between Delft University of Technology and Tecnia. The main objective of the course is to teach post-doctoral students, PhD students and researchers from the industry theoretical and practical lessons on multi-scale modelling, including up-scaling techniques. The course is structured as a 5 days program by teaching every day a different scale level. The course sequence is as follows: Monday – Macrolevel, Tuesday – Mesolevel, Wednesday – Microlevel, and finally, Thursday – Nanolevel. On Friday, upscaling issues of multi-scale modelling will be addressed (see Appendix 1). During the lunch breaks students are asked to present themselves by giving a very brief presentation about who they are and about their research interests. At the end of the course students are asked to fill in a course evaluation form which is used by the organizers to improve the quality of the course. The course ends by handing over a certificate to each student, together with an official document from TU Delft who valued the course as an official Post graduate course of 4.5 ECTS points. In this way PhD students can use the MMC course as an official course for their Post gradual program.

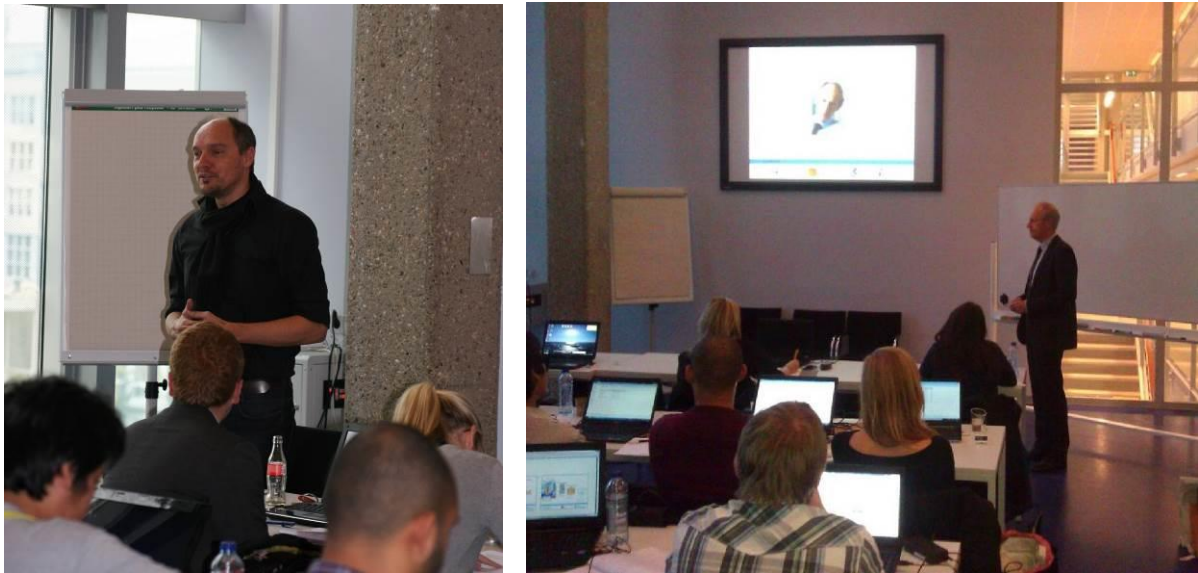


Fig 1: Lecture room of MMC 2013 course at Delft University of Technology. (Left) Dr. Koenders introducing the teachers and presenting the MMC course week, and (Right) Prof. van Breugel is welcoming the students on behalf of Delft University of Technology.

Course program:

The course program is designed in such a way that it provides theory during the morning sessions and hands-on practical sessions, with the use of software, during the afternoon. This concept turned out to be very successful and was appreciated by the participants very much. The software is prepared and provided by the teachers and is part of the course. Students can keep the software and use it for their personal research interests.

During the introduction session on Monday morning the course is opened by Prof. Klaas van Breugel (Fig 1). After that, Prof Erik Schlangen gives a welcome address on behalf of RILEM. He informs the students about the RILEM activities such as the Technical committees, the M&S Journal, etc, and informs them about the fact that PhD students are offered a 3 year free RILEM membership. The introduction of the teachers is done by Dr. Eddie Koenders after which a detailed overview of the course program is presented (Fig 1). After this students are informed about the possibility of presenting themselves during lunch break. After this introduction session, Prof Erik Schlangen starts the first course lecture about early age cracking at the macroscale, starting with the theory behind FEM-based simulations based on the FEMMASSE model. After that Dr. Eddie Koenders continues with the theoretical aspects of early age cracking. Then there is lunch and practical sessions in the

afternoon. After lunch a demonstration of the FEM model is given and after this the students use the FEMMASSE software themselves and model the early age behavior of a full scale structure.

Tuesday morning starts with the theory of mesolevel modelling by Prof Erik Schlangen (Fig 2a), starting with the fundamental mechanisms and models that can be used for mesolevel modelling for fracture mechanics and internal damage assessment. During this session the theoretical backgrounds and considerations of 3D lattice modelling is lectured by Dr. Zhiwei Qian (Fig 2d). After lunch demonstrations on 3D lattice simulations followed, and after this, students can use the 3D software themselves, and calculate a number of examples.



Fig 2a: Prof Schlangen teaching mesolevel modelling.



Fig 2b: Dr. Qian teaching mesolevel examples.

Wednesday morning the basic theory of microlevel modelling is lectured by Dr. Ye (Fig 3a), followed by the theory behind the models used to calculate microstructural properties by Dr. Eddie Koenders. In the afternoon, first a demonstration of the Hymostruc microlevel software is given followed by a session where students are asked to simulate a number of examples. This part turns out to be a very good experience for students that shows the link between theory and application.

Thursday morning, the Nano level modelling theory is scheduled. This part is lectured by Dr. Jorge Dolado (Fig 3b) and shows the details behind the molecular reactions of C-S-H. After this theoretical part a lunch is served. In the afternoon practical sessions on nanolevel modelling start with a demonstration of the software, and after that, students can use the software themselves and work out some exercises provided by the teacher. At the end of this day, a guided lab-tour is organized to the Macro and Microlab laboratories of the faculty of Civil Engineering and Geosciences of TU Delft. In the evening a MMC dinner is organized for all students, teachers and organizing staff.



Fig 3a: Dr. Ye teaching microlevel theory.



Fig 3b, Dr. Dolado explaining Nanolevel modelling and examples.



Friday morning starts with a lecture from Dr. Eddie Koenders addressing upscaling theory from nano to micro. After that, Dr. Zhiwei Qian continues with upscaling theory from micro- to macrolevel. Both lectures are emphasizing the scale effects in time and space and show how to transfer information between the scale levels. Dr. Ye is teaching the last lecture of the MMC course on the multi-scale simulation of durability. Emphasis is on simulating the chloride ingress and diffusion coefficient using Lattice Boltzmann schematization.

Target group:

The target group of the MMC course are PhD students, Postdoc researchers, Professors and researchers from companies.

Teachers:

The core group of teachers are: Prof.Dr. E Schlangen (TU Delft) / Dr G. Ye (TU Delft) / Dr E.A.B. Koenders (TU Delft, course responsible) / Dr. Z.Qian (TU Delft) / Dr. J. Dolado (Tecnalia, Spain). The different backgrounds and experiences of teachers is considered of vital importance for achieving a divers and comprehensive program of lectures, examples and exercises, and provides a broad vision on the different aspects associated with multiscale modelling.

Frequency and co-organization:

The MMC course is an official annual RILEM supported Educational Course. Up till now, the MMC course has been organized 6 times, i.e. in Delft (2008), Nanjing (2009), Bilbao (2010), Delft (2011), Nanjing (2012) and this year again in Delft (2013). Next year the MMC course will again be organized again by TU Delft in cooperation with Tecnalia. The selection of the teachers, lecture material and course program is under final responsibility of TU Delft.

Date:

The basic idea is to organize the course every year in the fall. In this way, the course is expected to be complementary to the CMC Microscopy course (also RILEM Educational course), which is organized in the spring. Each year the MMC course will be organized in October.

RILEM support:

RILEM guidelines are followed and a presentation about RILEM is given during the introduction session of the course.

Flyer:

Every year a new flyer is designed (Appendix 2) which shows the details of the MMC course including the logos of the participating organizations and the RILEM logo. Furthermore, since the event is an official RILEM course, MMC course information will also be available via the RILEM website. Besides this, the MMC course has also announced at the TU Delft website (www.mmc.citg.tudelft.nl).



APPENDIX 1

Course program



Indicative program of the MMC course

MMC 2013	Time	Monday	Tuesday	Wednesday	Thursday	Friday	
Theory	9.00 - 9.30	Welcome and Introduction session					
	9.30 - 10.15	Macro modelling FEMMASSE (1)	Meso modelling Fracture mechanics	Micro modelling Hydration / Microstructure	Nano modelling CSH development	Nano - to - Macro Upscaling techniques	
	10.15 - 10.45	Coffee break	Coffee break	Coffee break	Coffee break	Coffee break	
	10.45 - 12.15	Macro modelling (2)	Meso modelling Internal micro damage	Micro modelling Properties	Nano modeling Basic Building Blocks	Durability modelling from nano to macro	
	12.15 - 12.30	Macro modelling Temperatures & Stresses			Visit Microlab	Certificates	
	12.30 - 13.30	Lunch + presentations participants	Lunch + presentations participants	Lunch + presentations participants	Lunch + presentation participants	Lunch	
	Practical / Tutorial sessions	13.30 - 15.30	Macro FEMMASSE Demonstrations	Meso Lattice: Demonstrations	Micro Hymostruc: Demonstrations	Nano Tecnalia codes Demonstrations	
		15.30 - 16.00	Coffee break	Coffee break	Coffee break	Coffee break	
		16.00 - 18.00	Macro FEMMASSE Practical sessions	Meso Lattice: Practical sessions	Micro Hymostruc Practical sessions	Nano Practical sessions	
		18.00	Exploring Delft	Free	MMC Dinner	PSOR	



APPENDIX 2

Flyer MMC 2013



Current position (proof required)
PhD-, MSc-students, Postdocs

Costs (EUR)
850 euro

Professors / academic professionals

1300 euro

Professionals from industry

2550 euro

The cost for 2013 includes

- Course material -> handouts
- Lunch and refreshments during the day
- One Course dinner

Payment Information

Please follow the following payment procedure:
Make an online registration on the MMC website
(www.mmc.citg.tudelft.nl).

Cancellation policy

For Written cancellations received before 1st October 2013, registration fees will be fully refunded. For written cancellations received after 1st October 2013 no refund will be made.



Organized by:
Labein Tecnalia, NANOC, Bilbao, Spain
Microlab, Delft University of Technology,
The Netherlands
RILEM

<http://mmc.citg.tudelft.nl>

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Section Materials & Environment

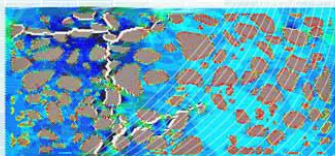
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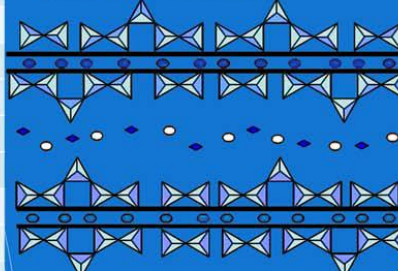
The Multi-scale Modelling Course for Concrete (MMC2) provides the opportunity for participants to become familiar with modelling cementitious materials at different levels of detail. Different ways of schematization and numerical approaches are considered to simulate the chemical, physical and mechanical behaviour of cementitious materials. The main backbone of the course are the different modelling levels at which heterogeneous and composite cementitious materials can be schematized and how these different levels can "communicate" by means of parameters passing methods or by using upscaling models.

The modelling levels that will be distinguished in this course are the nano-, micro-, meso- and the macro-level. The course emphasizes different modelling approaches for each scale level and shows a few conceptual techniques of how the "numerical gaps" can be bridged. The nano-level deals with molecular dynamics of CSH gel, the micro-level with hydration and microstructure, the meso-level with fracture mechanics and brittleness and for the macro-scale level emphasis will be on early-age cracking of hardening concrete and how to use commercial FEM software.

For the course participants, the MMC2 course provides the chance to acquire a glance of the varieties of the numerical possibilities in an intensive course week of lectures and workshops. The course is set-up in such a way that theoretical lectures and practice workshops alternate day by day and, besides this, course participants are also invited to present their own work during elevator pitch presentations. There will be a mix of events and topics centred around the theme of multi-scale modelling that makes the course very "dynamic".



Following the success of the past five MMC2 courses organized so far (Delft 2008, Nanjing 2009, Bilbao 2010, Delft 2011, Nanjing 2012), this year the course will again take place in Delft, in The Netherlands, and will be organized by the Microlab of Delft University of Technology. Lecturers are from Delft University of Technology, The Netherlands and Tecnalia research institute for nano technology, Spain, where the micro- to macro-scale level will be provided by teachers from Delft University and the nano-scale level by a teacher from Tecnalia. The upscaling lectures will be a joint contribution of lecturers from TU Delft and Tecnalia. Models will be presented that address the interfaces between all levels, which make the course a real multi-scale modelling course, i.e. from nano-to-macro!



SUMMARY

- ▶ Addressing lectures for nano to macro modelling.
- ▶ Theoretical and practical workshops on multi-scale modelling.
- ▶ Modelling mechanical, physical and chemical behaviour on different scale levels.
- ▶ Emphasizing different approaches of modelling and how "numerical gaps" can be bridge.

The MMC course is designed for:

- ▶ Graduate students (PhD, MSc students and Postdocs)
- ▶ Professors and other academic professionals
- ▶ Professionals from industry

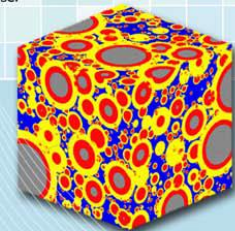
The course is intended for people working in areas where modelling knowledge of cement based materials can give you the edge in understanding problems and finding solutions.

The course level is suited for PhD candidates.

No special preliminary or initial training is required for this course, although it is presumed that the participant has basic knowledge of concrete and concrete composition.

In October 2013 the annual Fall Course Multiscale Modelling for Concrete will be held for the sixth time. The course is scheduled from Monday 21 to Friday 25 October 2013. The MMC Fall Course week will be scheduled at The Delft University of Technology, Delft The Netherlands.

Due to the limitation of 30 participants it would be recommended to register early. Last minute applications can not be guaranteed enrollment to the course.



www.be.net/IE-Design 2013
www.siecarepro.nl