

MMC 2016
17 – 21 October

RILEM EAC Evaluation report

Delft University of Technology
Technische Universität Darmstadt
Tecnalia, Spain

In co-operation with:

Southeast University, Nanjing, China
Jiangsu Subote New Materials Co, Nanjing, China

Venue:

Jiangu Subote New Materials Co.
Nanjing, China



Multi-scale Modeling Course for Concrete

*TU Delft/TU Darmstadt
November 20, 2016*



tecnalia
Cooperación Tecnológica
NANOC
Unidad Asociada



SOUTHEAST
UNIVERSITY



TU Delft
Delft University of Technology

Subject: Evaluation report MMC course 2016
Purpose: RILEM EAC feedback
Date: 20-11-2016
Authors: Prof. E.A.B. Koenders / Prof. E. Schlangen / Dr. G. Ye / Dr. J. Dolado

Venue: Jiangsu Subote New Materials Co.,
Nanjing, P.R. China



Fig 1: Lecture room of MMC 2016 course at Jiangsu Subote Institute of New Materials.

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

This year the course has been co-organized as a joint event between Delft University of Technology, Technische Universität Darmstadt, TecNALIA, Southeast University and Jiangsu Subote New Materials Institute and took place at the Jiangsu Subote Institute of New Materials (Fig 1). The main objective of the course was to teach post-doctoral students, PhD students and people from the industry the theory and practice of multi-scale modelling, including up-scaling techniques. The course is always scheduled in a scale level oriented teaching sequence (Macro, Meso, Micro and Nano), but this time, due to unforeseen matters, this order had to be slightly adapted to Monday – Macrolevel, Tuesday – Microlevel, Wednesday – Mesolevel and finally Thursday – Macrolevel, covering the full 5 days program, and emphasizing every day a different scale level. At Friday, the interfaces and upscaling issues of multi-scale modelling were taught. During the morning and afternoon coffee breaks students were asked to present themselves by giving a very brief presentation about who they are and about their research interest. After the course students were asked to fill in a course evaluation form of which the results are attached to this report in Appendix 1.

2. Program:

In line with the previous year's courses, the course program was designed in such a way that the course 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 was prepared and provided by the teachers and was part of the course. Students can keep most of the software and use it for their personal research interests.

During the introduction session on Monday morning the course was officially opened by Prof. Jiaoping Liu and Prof. Eddie Koenders. After that, Dr. Ye Guang gave a welcome address on behalf of RILEM. The introduction of the teachers was done by Prof. Eddie Koenders together a detailed overview of the course program for the whole week. After that Dr. Chen Yu, Ms. Cuicui Chen and Dr. Yu Yan from Jiangsu Subote New Materials Institute and Dr. Ye Guang and Ms. Iris Batterham from TU Delft, were gratefully acknowledged for their support and organization of the course and special thanks were addressed to Prof Miao Changwen for his thorough support of the MMC course.

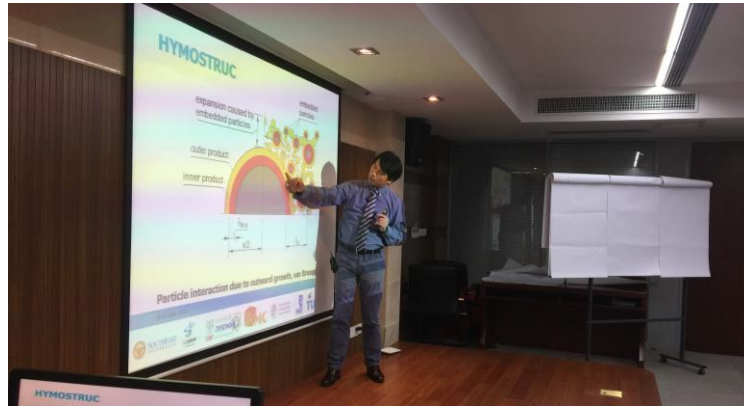


Fig 2: Dr. Ye teaching microlevel theory.

After the introduction session the official program started with the Macrolevel modelling theory. The lectures started with the theory behind FEM-based simulations based on the FEMMASSE model given by Prof. Eddie Koenders, representing Prof. Erik Schlangen. After the coffee break, Prof. Eddie Koenders continued with a lecture on the theoretical backgrounds of early age temperature and stress development in hardening concrete. After lunch a demonstration of the FEM model was given by Dr. Zhiwei Qian, followed by a self-training part where students could use the FEMMASSE software themselves and model the early age behavior of a full scale structure.

On Tuesday morning the basic theory of microlevel modelling was lectured by Dr. Ye (Fig 2), followed by the theory behind the models used to calculate microstructural properties by Prof. Eddie Koenders. In the afternoon, first a demonstration of the Hymostruc microlevel software was given by Prof. Eddie Koenders, followed by a practical session guided by Dr. Ye, where students were asked to simulate a number of examples at the microlevel. This part turned out to be very well received by the students who could directly experience the link between theory and application.

Wednesday morning started with the theory of mesolevel modelling and was given by Dr. Zhiwei Qian, 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 was lectured by Dr. Zhiwei Qian. After lunch demonstrations on 3D lattice simulations followed and after this, students could use the 3D software themselves, and were asked to calculate a number of examples. After the lectures all students and teachers went to Nanjing for a city tour and to have a dinner together (see Fig. 3).



Fig 3: All students and teachers went to Nanjing city for a tour and a dinner.

Thursday lecture was taught by Dr. Jorge Dolado, starting with a brief overview of the theory behind nanoscale modelling of C-S-H gel formation. After coffee break he continued with the formation of the basic building blocks. After this block of theory a guided tour was organized to visit the laboratories of the Jiangu Subote New Materials institute, followed by a lunch. In the afternoon the practical sessions on nanolevel modelling started with a demonstration of the software, and after that, students could use the software themselves and work out the exercises provided by the teacher.

Friday morning started with a lecture of Dr. Zhiwei Qian addressing different upscaling theories about passing modelling information from the nano up to the macrolevel. After the coffee break Dr. Ye gave a lecture on multi-scale durability modelling. Both lectures where emphasizing the scale effects in time and space and show how to transfer information between the scale levels. A final lecture was addressed by Prof. Huisu Chen about transport modelling as a multiscale approach. A full overview of the program is given in Appendix 2.

On Friday, after the lectures had ended, the official graduation ceremony started by handing over all students a certificate of attendance. This official part was done by Prof. Miao, Prof. Liu and Dr. Ye (see Fig 4 and 5).



Fig 4: Prof. Miao announcing the Graduation Ceremony to hand over the certificates to the students.



Fig 5: Students received the MMC certificates from Prof. Miao, Prof. Liu and Dr. Ye.

3. Number of persons:

The official number of participants attending the MMC course was 73 (excluding teachers). From these, 5 were from outside China, i.e. one student from India, two students from The Netherlands and two students from Belgium.

4. Target group:

The target group was as expected, i.e. PhD and Postdoc level and complied with the objective of the MMC course. The focus of the co-organizers was mainly on training PhD students. The students were very active, created a good atmosphere for discussions with the teachers and provided fresh and helpful input to the course.

5. Country of participants:

The attendees of the MMC course came from 4 different countries. All of them were PhD students. A complete overview of the participants is given in Appendix 3. A group photo of the MMC course participants is shown in Appendix 4.

6. Teachers:

The teachers; Prof. Dr E.A.B. Koenders (TU Darmstadt) / Dr. G. Ye (TU Delft) / Dr. Z.Qian (TU Delft) / Dr. J. Dolado (Tecnalia, Spain) / Prof. Huisu Chen (South East University), all teachers showed professional skills and all were very much able to present inspiring lectures to the students during the theoretical morning sessions as well as during the practical afternoon sessions and supervision of the students. The different backgrounds and experiences of the teachers is considered very important to achieve a diverse and comprehensive program of lectures, examples and exercises, and provides a broad vision on the different aspects associated with Multiscale modelling.

7. Frequency and co-organization:

The MMC course is an official annual RILEM EAC supported educational course. Up till now, the MMC course has been organized 9 times, i.e. in Delft (2008), Nanjing (2009), Bilbao (2010), Delft (2011), Nanjing (2012), Delft (2013), Beijing (2014), Darmstadt (2014) and Nanjing (2016). This year it was the third time that the Jiangu Subote New Materials institute co-organized the MMC course in China which is greatly appreciated by all involved institutes and shows the sustained interest and cooperation among the organizing RILEM partners. Next year the MMC course will be organized at TU Delft again. The selection of the teachers, lecture material and course program will be under final responsibility of TU Delft.

8. 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 RILEM CMC Microscopy course (also RILEM course), which is always organized in the spring. This year the MMC course was organized from October 17 to 21.

9. RILEM support:

RILEM requirements are always followed by means of a presentation about the RILEM organization, given during the introduction session of the course. During this MMC course in Nanjing the RILEM presentation was given by Dr. Ye Guang as part of the official opening ceremony.

10. Flyer:

Every year a new flyer is designed (Appendix 5) 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.

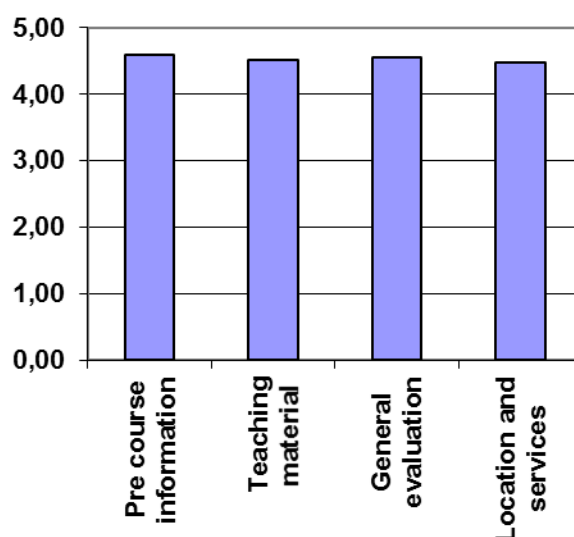
APPENDIX 1

Evaluation report of participants

Evaluation results MMC 2016

Participant evaluation results	
5 = High, 1 = Low	
Pre course information	Average
available information before course started	4,67
telefonical contact	4,47
written contact	4,66
workbook	4,59
Teaching material	
context of teaching material	4,73
content of teaching material	4,72
practical usability	4,34
level of teaching material	4,28
General evaluation	
opinion total course	4,59
was course what you expected	4,52
Location and services	
accessibility	4,25
quality	4,44
coffee breaks and lunches	4,55
course dinner	4,69

Overall MMC 2016



APPENDIX 2

Course program

Program of the MMC 2016 course

MMC	Time	Monday 17 Oct.	Tuesday 18 Oct.	Wednesday 19 Oct.	Thursday 20 Oct.	Friday 21 Oct.
	9:00 - 9:30	Welcome and Introduction session	Micro modelling (1) Hydration / Microstructure Guang Ye	Meso modelling Fracture mechanics Erik Schlangen (Zhiwei Qian)	Nano modelling CSH development Jorge Sanchez Dolado	Durability modelling from nano to macro Guang Ye
	9:30 - 10:15					
Theory	10:15 - 10:45	Coffee break + Introduction participants	Coffee break + Introduction participants	Coffee break + Introduction participants	Coffee break + Introduction participants	Coffee break + Introduction participants
	10:45 - 11:30	Macro modelling (2) Erik Schlangen (Eddie Koenders)	Micro modelling (2) Hydration / Microstructure Guang Ye	Meso modelling Internal micro damage Zhiwei Qian	Nano modeling Basic Building Blocks Jorge Sanchez Dolado	Mechanical modelling from micro to macro Zhiwei Qian
	11:30 - 12:15	Macro modelling Temperatures & Stresses Eddie Koenders	Micro modelling Properties Eddie Koenders		Lab visit Jiangsu Bote New Materials Co.	Transport modelling Huisu Chen
	12:30 - 14:00	Lunch	Lunch	Lunch	Lunch	Lunch + Certificates
Practical / Tutorial sessions	14:00 - 15:30	Macro FEMMASSE Demonstrations	Micro Hymostruc Demonstrations	Meso Lattice Demonstrations	Nano Tecnalia codes Demonstrations	
	15:30 - 16:00	Coffee break + Introduction participants	Coffee break + Introduction participants	Coffee break + Introduction participants	Coffee break + Introduction participants	
	16:00 - 18:00	Macro FEMMASSE Practical sessions	Micro Hymostruc Practical sessions	Meso Lattice Practical sessions	Nano C4 Practical sessions	
	18:00	Free	Free	City walk and MMC course dinner	Free	

APPENDIX 3

List of participants 2016

#	Prefik	First name	Last name	Organization	Email
1	Mr	Jiuwen	BAO	Dalian University of Technology	baojiuwen55@126.com
2	Mr	Xiaoyu	CAO	Southeast University	15851869792@163.com
3	Mr	Yuanzhang	CAO	Southeast University	465799028@qq.com
4	Mr	Ruilin	CAO	Southeast University	caoruilin1991@163.com
5	Mr	Weiqun	CAO	Qingdao University of Technology	qdcaweiqun@163.com
6	Miss	Lijuan	CHAI	Southeast University	572068470@qq.com
7	Mr	Stefan	CHAVES FIGUEIREDO	Delft University of Technology	s.chavesfigueiredo@tudelft.nl
8	Mr	Weiwei	CHEN	China University of Mining and Technology	chnw_1125@126.com
9	Mr	Yang	CHEN	South China University of Technology	524087253@qq.com
10	Mr	Ruixing	CHEN	Southeast University	crx31824@163.com
11	Mr	Jun	CHENG	Southeast University	152290629@qq.com
12	Miss	Lin	CHI	Harbin Institute of Technology	chilin8958@163.com
13	Miss	Yuan	CONG	Qingdao University of Technology	1004221002@qq.com
14	Mr	Yuvraj	DHANDAPANI	IIT Madras	dyuvraj@gmail.com
15	Miss	Fengyin	DU	Qingdao University of Technology	804777132@qq.com
16	Miss	Anastasia	GARPOVA	Harbin Institute of Technology	obldorstroy@mail.ru
17	Mr	Zhongzheng	GUAN	Beijing University of Technology	8201504021@emails.bjut.edu.cn
18	Mr	Zhi	HU	Shanghai Jiao Tong University	huzhigu@126.com
19	Mr	Tengfei	HUA	Chongqing University	htf1987910@126.com
20	Mr	Yongbo	HUANG	Chongqing University	h670598410@163.com
21	Miss	Yudan	JIANG	Qingdao University of Technology	31017673@qq.com
22	Mr	Wenqiang	JIANG	Shanghai Jiao Tong University	381716474@qq.com
23	Mr	Fefei	JIANG	Nanjing Tech University	375916069@qq.com
24	Mr	Wei	LEE	Nanjing Tech University	stevenlee187@126.com
25	Mr	Zhe	LI	Qingdao University of Technology	476872805@qq.com
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27	Mr	Yaqiang	LI	Beijing University of Technology	yaqiangli@163.com
28	Miss	Zhen	LI	Southeast University	listener122000@126.com
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31	Mr	Rui	LIU	Harbin Institute of Technology	llurayy@163.com
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33	Mr	Yunfeng	PAN	Huanan Research Institute of Hohai University	panpan720@hhu.edu.cn
34	Mr	Rusheng	QIAN	Southeast University	1352151454@qq.com
35	Mr	Fangzhou	REN	Harbin Institute of Technology	renfangzhou@139.com
36	Miss	Xiaohan	SHEN	Shanghai Jiao Tong University	shxhynn@126.com
37	Mr	Alexandru	STERPU	Hasselt University	alexandru.sterpu@uhasselt.be
38	Mr	Jinhui	TANG	Southeast University	t_jinhui@163.com
39	Mr	Zushi	Tian	Zhejiang University	tianzushi@icloud.com
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41	Miss	Wenting	WANG	Hohai University	935905941@qq.com
42	Miss	Xiaoxian	WANG	Qingdao University of Technology	449550895@qq.com
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47	Mr	Jiang	WU	South China University of Technology	532982367@qq.com
48	Mr	Yu	XIANG	Central South University	289629600@qq.com
49	Mr	Dong	XU	China University of Mining and Technology	376221829@qq.com
50	Miss	Weiting	XU	Hong Kong Polytechnic University	weitingxu@gmail.com
51	Mr	Zhencal	XU	Chongqing University	2275601614@qq.com
52	Mr	Yu	YAN	Southeast University	yanyu_159483@163.com
53	Mr	Haonan	YANG	Harbin Institute of Technology	609525273@qq.com
54	Mr	Yuanquan	YANG	Shenyang Ligong University	aquarius0109@163.com
55	Mr	Zhiqiang	YANG	Southeast University	scyqiang@163.com
56	Miss	Kali	YANG	Chongqing University	572736933@qq.com
57	Mr	Peng	YUAN	Southeast University	310435654@qq.com
58	Miss	Wenjie	ZANG	Southeast University	814218262@qq.com
59	Mr	Shupeng	ZHANG	Nanjing Tech University	815806703@qq.com
60	Miss	Shiping	ZHANG	Nanjing Institute of Technology	zhangshiping1982@126.com
61	Miss	Junhui	ZHANG	Harbin Institute of Technology	1278959179@qq.com
62	Mr	Jer	ZHANG	Southeast University	249993721@qq.com
63	Mr	Shizhe	ZHANG	Delft University of Technology	shizhe.zhang@tudelft.nl
64	Mr	Guosheng	ZHANG	Beijing University of Technology	guosheng_z@163.com
65	Mr	Hao	ZHANG	Southeast University	503013461@qq.com
66	Mr	Zengfeng	ZHAO	University of Liege	zengfeng.zhao@ulg.ac.be
67	Mr	Shengying	ZHAO	Harbin Institute of Technology	168933033@STU.HIT.EDU.CN
68	Mr	Dezhi	ZHAO	Harbin Institute of Technology	zhaodezhihit@126.com
69	Mr	Qi	ZHENG	Southeast University	Nigel_Zheng@yahoo.com
70	Mr	Peihua	ZHONG	Southeast University	905691140@qq.com
71	Mr	Jin	ZHOU	Central South University	158771348@qq.com
72	Mr	Jiang	ZHU	Chongqing University	zjiangy@163.com
73	Mr	Chao	ZOU	Central South University	429661336@qq.com

APPENDIX 4

Group photo MMC 2016



APPENDIX 5

Flyer MMC 2016

Cost

Current position	Costs (EUR)
Participants from China	350
PhD-, MSc-students (proof required)	750
Postdocs	750
Professors / academic professionals	1250
Professionals from industry	2500

The cost includes:

- Course material: handouts
- Accommodation
- Lunches and meals for one week

Accommodation

Please send your reservation request to the course organizer.

Further information

Workshop website: <http://www.mmc.citg.tudelft.nl>

For registration and additional course information, please contact:

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Subote New Materials Co., LTD.

Telephone: +86 25 52839750
Email: chenCuicui@cnjsjkc.cn

Prof. Dr. Eddie Koenders
Technical University of Darmstadt
Institute of Construction and Building Materials
Darmstadt, Germany
Email: koenders@wib.tu-darmstadt.de

Dr. Guang Ye (Intermediate China-Delft)
Delft University of Technology,
MicroLab
2600 GA Delft
Email: g.ye@tudelft.nl

Lecturers

Eddie Koenders, Guang Ye, Jorge S. Dolado,
Erik Schlangen, Huisu Chen, Zhiwei Qian

Board members

Wei Sun, Klaas van Breugel, Changwen Miao,
Jiaoping Liu

Sponsored by

Subote New Materials Co., LTD.
Southeast University
Materials & Environment, MicroLab,
Delft University of Technology
Institute of Construction and Building Materials
Technische Universität Darmstadt
Tecnalia, Research Institute for Nanotechnology, Spain
RILEM

MMC	Time	Monday	Tuesday	Wednesday	Thursday	Friday
Theory	9:00-9:30	Micro and meso modelling (Eddie Koenders)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	9:30-10:15	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	10:15-10:45	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	10:45-11:30	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
Practical Training	11:30-12:15	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	12:30-14:00	Lunch	Lunch	Lunch	Lunch	Lunch
	14:00-15:30	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	15:30-16:30	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
Free time	16:30-18:00	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)	Micro-modelling (1) (Erik Schlangen)
	18:30	City walk	Free	Free	Free	Free



Multi-Scale Modelling Course for Concrete MMC²

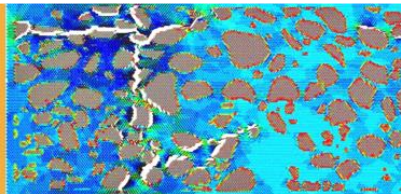
Nanjing, 17-21 October 2016

Scope of the course

The RILEM Multi-scale Modelling Course for Concrete (MMC²) provides the opportunity for participants to become familiar with modelling cementitious materials at four 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 through upscaling models. The modelling levels that will be taught in this course are the macro-, meso-, micro-, and nano-level.

The course emphasizes different modelling approaches for each scale level and shows a couple of conceptual techniques on how "numerical gaps" between scale levels can be bridged. The course commences with the macro-scale level where emphasis is on early-age temperature and stresses development of hardening concrete, and how commercial FEM software can be applied. The meso-level deals with fracture mechanics and brittleness with emphasis on the Lattice model, followed by the micro-level which is on the hydration and microstructure properties using pixel and vector-based approaches, and finally, the nano-level dealing with the backgrounds C-S-H gel using molecular dynamics and ab initio schemes. For the course participants, the MMC² course provides a chance to acquire a glance of the varieties of numerical possibilities in an intensive course week of lectures and workshops. The course is set-up in such a way that theoretical lectures and practical workshops alternate day by day and, besides this, course participants are also invited to present themselves during elevator pitch talks. 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 eight MMC² courses organized so far (Delft 2008, Nanjing 2009, Bilbao 2010, Delft 2011, Nanjing 2012, Delft 2013, Beijing 2014, Darmstadt 2015), the 2016 course will be organized in Nanjing again and co-organized by Southeast University, China, the MicroLab of Delft University of Technology and Subote New Materials Co., LTD. Lecturers are from Delft University of Technology in The Netherlands, Technical University of Darmstadt in Germany, Tecnalia research Institute for nanotechnology in Spain and from Southeast University, China.



University in China. Lecturers from Delft and Darmstadt University will teach the micro- to macro-scale level whereas lecturers from the Tecnalia research institute will account for the nano-scale level. The upscaling lectures will be a joint contribution of lecturers from Delft, Darmstadt and South East University and show how to model the scale interfaces which make the course a real multi-scale modelling course, i.e. from nano-to-macro!



Participants

- 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 and/or Postdoc 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.

Lecture material consists of a USB-stick containing all PPT slides in PDF format as presented during the course, literature, practical examples, a copy of the basic software that will also be used during the practical sessions.

When

In annual RILEM Multiscale Modelling for Concrete will be organized in Nanjing and is scheduled from: Monday October 17 to Friday October 21, 2016, which will be the week prior to the Microdurability conference.

Where

The MMC Fall Course week will be organized in Nanjing, China, where the Jiangsu Bote New Materials Co. will host of the MMC course 2016.

Nanjing is the capital of China's Jiangsu Province and a city with a prominent place in Chinese history and culture. Nanjing has served as the capital of China during several historical periods, and is listed as one of the Seven Great Ancient Capitals of China. (The other Six: Beijing, Xi'an, Luoyang, Hangzhou Anyang and Kaifeng).

Nanjing is also one of the fifteen sub-provincial cities in China's administrative structure, enjoying jurisdictional and economic autonomy province.

