TECHNICAL REPORT
2018–2019

International Union of Laboratories and Experts
in Construction Materials, Systems and Structures

RILEM
TECHNICAL REPORT

About RILEM

The International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM, from the name in French) was founded in June 1947 in Paris, France, with the aim to promote scientific cooperation and to stimulate new directions for research and applications, thus promoting excellence in construction worldwide.

This mission is fulfilled through the collaboration of leading experts in construction science and practice, including academics, researchers, industrialists, testing laboratories, and authorities.

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Membership benefits include:

- Participation in RILEM Technical Committees
- Access to the private Web directories restricted to RILEM Members and Online version of the RILEM Directory of Members,
- Personal access after login online to the journal Materials and Structures, RILEM Proceedings and Springer/ Nature proceedings
- Reduced fees for RILEM events
- 30% discount on printed RILEM publications
- 20% discount on all Springer / Nature e-books
- Opportunity to publish selected articles as free Open Access paper in Materials & Structures and in RILEM Technical Letters

Individual fees in 2019:

Student Member: 25 euros
Affiliate Member: 100 euros
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Corporate fees in 2019:

Institutional Member: 2205 euros
Industrial Member: 4050 euros
Associate Member: 1165 euros

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Editorial
by RILEM TAC Chair Nele De Belie

This year I had the honour to take over the position of chair of the RILEM Technical Activities Committee (TAC) from Dr. Nicolas Roussel, whose mandate expired in August 2018. I would like to take advantage of this editorial to thank Nicolas for his excellent work and to wish him well in his new role of RILEM Vice president.

It is with great pleasure that I write the Editorial of this first RILEM Annual Technical Report!

RILEM has desired the publication of such a report for a long time but logistical issues prevented this to happen so far. This report aims to turn the spotlight on the hard work of all the current RILEM Technical Committees. It provides an opportunity for them to present their achievements, publications, plans and their progress over the years. The contents presented here, organised per cluster, cover the life span of each TC from its starting date to August 2019. It also provides a list of upcoming reports and TC workshops and events.

The TCs form the heart of RILEM, or maybe rather the hands and feet… It is where all the action happens. In a TC, you can discuss with the experts, and experts-to-be, in a specific field. You give and receive advice, you carry out joint research and inter-laboratory tests at an international level, you contribute to recommendations that will be used by scientists and practitioners the years to come. In meetings around the world, you discover relevant research tools in your colleagues' labs, you come in touch with other cultures and make many new friends. To be a member of a TC opens more doors than you could have imagined.

TAC supports the TCs over the complete course of their 5 years lifetime. TAC helps to identify promising topics for the launch of a new TC, and experts who could take the lead. Hence, RILEM can remain at the forefront of research in established domains, but also in newly emerging fields like circular economy, sustainability, digital fabrication, etc. TAC gives advice while the idea of a new TC is taking shape, follows up the activities when the TC is active and screens the final outcome. The cluster conveners keep the overview of the TCs in a certain area, so that they can identify synergies.

TAC is an evolving and never resting committee; recently, some mandates expired and new members joined TAC. Here comes a short summary:

- Cluster C convener Takafumi Noguchi was succeeded by Giovanni Plizzari
- Cluster F convener Hervé Di Benedetto was succeeded by Michael Wistuba
- Cluster E convener Robert Flatt was succeeded by Enrico Sassoni
- Expert Viktor Mechtcherine was succeeded by Kei-ichi Imamoto
- Expert Giovanni Plizzari was succeeded by Sergio Cavalaro
- Expert Jay Sanjayan was succeeded by Daman Panesar
- Expert Barbara Lubelli was succeeded by Arun Menon
- Expert Michael Wistuba was succeeded by Eshan Dave
- A special additional mandate (2018-2020) was given to expert Hervé Di Benedetto

I would like to thank all the members leaving TAC (cluster conveners and experts) for their outstanding work over the last years, and the members continuing in TAC for their ongoing commitment.

TAC meets twice a year: during the RILEM Annual Week and during the Spring Convention.
In Rovinj (Croatia) in March 2019, during the most recent RILEM Spring Convention, several TC related decisions were discussed and taken by TAC:

- Two TCs were given a number: TC 282-CCL and TC 283-CAM.
- Several TCs reached the end of their lifetime and were closed: 247-DTA, 244-NUM, 249-ISC, 254-CMS and 250-CSM.
- Following TCs will present their achievements at the Technical Day of the 2019 RILEM Annual Week in Nanjing (China): 267-TRM, 252-CMB, 253-MCI and 255-FRS.
- Furthermore, around five TCs will present their work at the 2020 RILEM Annual Week in Sheffield (UK).
- Three new TC proposals were approved:
  - > DCM: Long-term durability of structural concretes in marine exposure conditions (chaired by Kefei Li) in Cluster D, Kick-off meeting in June 2019;
  - > GDP: Test Methods for Gas Diffusion in Porous Media (chaired by Bruno Huet) in Cluster B;
  - > IMC: Durability of Inorganic Matrix Composites used for Strengthening of Masonry Constructions (chaired by Maria Antonietta Aiello) in Cluster E, Kick-off meeting in June 2019.
- TAC was glad to see that several new proposals are in the pipeline to be submitted soon. Some are follow-ups of closing TCs and others are brand-new projects. The reader will learn more about this in the 2019-2020 Annual Technical Report.
- Last but not least, I would like to acknowledge the collaboration of RILEM with the fib Model Code 2020 initiative (for more details, please read TC IEC on page 39). This partnership brings many mutual benefits. RILEM TC members are proud of being part of this alliance.

I hope that this technical report will be a source of inspiration and that it will help you to identify TCs that you may want to join and actively contribute to.

Enjoy reading!

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An overview of the 2nd RILEM Spring Convention in Rovinj, Croatia

The 2nd RILEM Spring Convention kicked off on Monday morning, 18 March and progressed through two very intense working days.

RILEM and the local hosts offered members and other Convention participants the opportunity to meet at the nourishing and comfortable environment of the Hotel "Lone" in Rovinj, Croatia. The meetings ran in nine parallel sessions held in large and well-equipped rooms. In between them, relaxing coffee breaks and lunches allowed all RILEM members to meet friends and colleagues from around the world.

The following Technical Committees participated in the event to discuss on the progress of their activities:

- TC 247-DTA: Durability testing of alkali-activated materials
- TC 254-CMS: Thermal cracking of massive concrete structures
- TC 258-AAA: Avoiding alkali aggregate reactions in concrete - Performance based concept
- TC 262-SCI: Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion
- TC 267-TRM: Tests for reactivity of supplementary cementitious materials
- TC 269-IAM: Damage Assessment in Consideration of Repair/ Retrofit-Recovery in Concrete and Masonry Structures by Means of Innovative NDT
- TC 270-CIM: Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice
- TC 274-TCE: Testing and characterisation of earth-based building materials and elements
- TC 277-LHS: Specifications for testing and evaluation of lime-based repair materials for historic Structures
- TC 280-CBE: Multiphase characterisation of cold bitumen emulsion materials
- TC 281-CCC: Carbonation of concrete with supplementary cementitious materials
- TC CAM: Chloride transport in alkali-activated materials
- TC CCH: Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete-Reinforcing Steels
- TC CCL: Calcined Clays as Supplementary Cementitious Materials

Hotel Lone in Rovinj (Croatia). Courtesy of Maistra group.

TC members at work in Rovinj.
Courtesy of Karmen Kostanic Juric.

An overview of the 2nd RILEM Spring Convention in Rovinj, Croatia

Mrs Pascale Ducornet, Secretary General leaving RILEM at the end of 2019 after almost 25 years of service.
Courtesy of Ravindra Gettu.

All RILEM members attending the Spring Convention were invited to a delightful dinner in Pula, some 40 km from Rovinj, on the first night of the RILEM Spring Convention. The local organising committee of the International Conference on Sustainable Materials, Systems and Structures (SMSS2019, http://grad.hr/rilem.smss) that was held together with the RILEM Spring Convention, organised traditional entertainment during the dinner with folkloristic dances and music.

At the dinner, we paid farewell to Madame Pascale Ducornet, who will leave her position of RILEM Secretary General in October 2019 to enjoy her well-deserved retirement after almost 25 years of duties! With her gentle and calm personality, characterised by a strong determination, she has been the pillar of RILEM through some rocky transitional periods and always a strong reference point for the organization.

The RILEM standing committees, i.e. the Technical Activities Committee (TAC), the Development Advisory Committee (DAC) and the Bureau, also had two very busy days with a tight agenda of meetings. The main outcomes of the TAC meetings can be seen in the Editorial by the RILEM TAC Chair Nele De Belie at the beginning of this report. The Bureau meetings gave the opportunity to introduce Judith Hardy, future Secretary General replacing Madame Pascale Ducornet in October, and Daniela Ciancio, the new RILEM Implementation Manager (RIM). At the same meetings, the following points were highlighted:

- The Regional Convener positions for EAST ASIA and PACIFIC AREA remain open. RILEM is accepting candidatures!
- The special issue for the 50-year anniversary of Materials and Structures is on-line. The articles of this special issue are published OPEN ACCESS.
- Alexandra Bertron has been appointed new Editor in Chief of RILEM Technical Letters.

The next RILEM Spring Convention will be in Guimarães, Portugal, in March 2020. Looking forward to meeting you all again there!

Folkloristic dance in Pula (Croatia) at the RILEM Spring Convention dinner.
Courtesy of Daniela Ciancio.

Technical Committees (TCs): The heart of RILEM

WHAT IS A RILEM TC?

A group of international experts working together in a particular field in order to:

- Assemble and evaluate research data;
- Harmonise testing methods ;
- Suggest new topics for research (also research not to be directly undertaken by RILEM TCs);
- Promote their conclusions.

HOW IS A RILEM TC CREATED?

An application is filled and signed by the proposed TC Chair, who has to be a RILEM Senior Member. This form is sent to the RILEM General Secretariat that forwards it to each RILEM Technical Activities Committee (TAC) member for comments and discussion. If needed, a revised proposal might be drafted by the proposed TC Chair to fulfil the TAC recommendations.
After recommendation by the TAC and approval by the RILEM Bureau and General Council, which verifies that the terms of reference of the proposed TC fit into the technical programme of RILEM, the TC is officially created.

ROLE OF RILEM CLUSTERS

Each RILEM TC is in direct connection with a RILEM Cluster. This body is entrusted with co-ordinating and monitoring the activities of its TCs and with advising the TAC. This co-ordination is convened by the Cluster conveners.

LIFESPAN OF A TC

The TC duration is usually limited to 5 years. Under certain circumstances, the lifespan of a TC might be stretched but it cannot be any longer than 7 years.

TC MEMBERS

Each TC member is appointed by the TC Chair. All TC members should be members of RILEM.
Recently the RILEM Bureau approved a new policy according to which an application to join a TC cannot be rejected as long as the applicant complies with the only two requirements, i.e. 1) being a RILEM member and 2) active contribution to the production and discussion of the working documents. PhD students and young researchers are strongly encouraged to join a TC.

TECHNICAL BENEFITS OF TC MEMBERS

Each RILEM TC member receives:

- Access (with user name and password) to the private directories of the RILEM TC hosted at ***www.rilem.net***, where working documents, agendas and minutes of the TC (uploaded directly by the TC Chair or Deputy chair) can be downloaded;
- Access to each document produced by the RILEM Technical Committee;
- Free access to online reports and proceedings of conferences published at ***www.rilem.net***
- The RILEM Annual Report and the Directory of Members.

Technical Committees (TCs): The heart of RILEM

REWARDS FOR TC MEMBERS

Beside the above-mentioned technical benefits, being a TC member offers other more valuable rewards.
For young researchers, belonging to a TC means being in touch with the most knowledgeable experts of the areas of research covered by the TC and therefore working in a nourishing and stimulating environment. It also means creating an important network of contacts that can only be advantageous for their career.
For senior members, the TC is an opportunity to mentor younger people, to put their experience and knowledge at the service of a wider community and to share expertise for the benefit of the society.

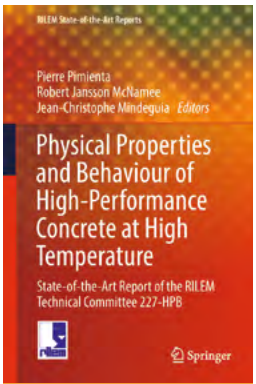
OUTCOMES OF A TC

Each TC is expected to produce at the end of its lifespan one or some of the following:

- A bibliography
- One or more recommendations for test methods or construction practice
- A state-of-the-art report (STAR)
- Other educational material

STAR

Since 2009, RILEM State-of-the-Art reports are published by Springer. These reports constitute a critical appraisal of current knowledge on a specific research subject. They often identify gaps in knowledge, thereby contributing to the development of strategies and scenarios for future research. Springer RILEM State-of-the-Art reports are indexed by SCOPUS, Google Scholar and SpringerLink.
RILEM is not allowed to distribute the reports for free. However, one can find the unedited version of each RILEM STAR, as PDF «unedited version» and **DOWNLOAD IT FOR FREE** from the RILEM web page.



▲ *Springer 2019.*

RECOMMENDATIONS

Over 200 RILEM Technical Recommendations have been produced by RILEM Technical Committees. Many of these recommendations have been adopted in research and practice, and are used by international standardisation bodies, as a basis for their work. In the last few years, RILEM recommendations have been published in the form of journal papers in Materials and Structures. A special agreement with Springer makes these publications open access and therefore **TO BE DOWNLOADED FOR FREE.**

Active TCs at a glance

TC NUMBER	TC ACRONYM	TC TITLE	CLUSTER	TC CHAIR	TC DEPUTY CHAIR	ACTIVITY STARTED IN	TC CLOSED IN MARCH 2019
260	RSC	Recommendations for use of superabsorbent polymers in concrete construction	A	Viktor MECHTCHERINE	Mateusz WYRZYKOWSKI	2014	
261	CCF	Creep behavior in cracked sections of fiber reinforced concrete	A	Pedro SERNA ROS	Sergio Henrique PIALARISSI CAVALARO	2014	
266	MRP	Measuring rheological properties of cement-based materials	A	Mohammed SONEBI	Dimitri FEYS	2015	
267	TRM	Tests for reactivity of supplementary cementitious materials	A	Karen SCRIVENER	Ruben SNELLINGS	2015	
275	HDB	Hygrothermal behaviour and durability of bio-aggregate based building materials	A	Sofiane AMZIANE	Florence COLLET	2016	
276	DFC	Digital fabrication with cement-based materials	A	Nicolas ROUSSEL	Dirk LOWKE	2016	
282	CCL	Calcined clays as supplementary cementitious materials	A	José Fernando MARTIRENA-HERNANDEZ	Manu SANTHANAM	2018	
	AMC	Use of agro-based materials as cementitious additions in concrete and cement-based materials	A	Said KENAI	Mike B. OTIENO	2018	
	CEC	Controlled expansion of concrete by adding MgO-based expansive agents taking the combined influence of composition and size of concrete elements into consideration	A	Jiaping LIU	Ole Mejlhede JENSEN	2018	
247	DTA	Durability testing of alkali-activated materials	B	John PROVIS	Frank WINNEFELD	2012	❖
251	SRT	Sulfate resistance testing	B	Véronique BAROGHEL-BOUNY	Esperanza MENENDEZ MENDEZ	2013	
253	MCI	Microorganisms-cementitious materials interactions	B	Alexandra BERTRON	Henk JONKERS	2014	
262	SCI	Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion	B	Ueli ANGST	Mette GEIKER	2015	
281	CCC	Carbonation of concrete with supplementary cementitious materials	B	Nele DE BELIE	Susan BERNAL	2018	
283	CAM	Chloride transport in alkali-activated materials	B	Arnaud CASTEL	John PROVIS	2018	
	FTC	Durability and service life of concrete under the influence of freeze-thaw cycles combined with chloride penetration	B	Folker H. WITTMAN	Peng ZHANG	2018	
	TMS	Test method for concrete durability under combined role of sulphate and chloride ions	B	Changwen MIAO	Geert de SCHUTTER	2018	
	GDP	Test methods for gas diffusion in porous media	B	Bruno HUET	Pilippe TURCRY	2019	
244	NUM	Numerical modelling of cement-based materials	C	Klaas VAN BREUGEL	Ravi PATEL	2011	❖
249	ISC	Non destructive in situ strength assessment of concrete	C	Denys BREYSSE	Jean-Paul BALAYSSAC	2012	❖
254	CMS	Thermal cracking of massive concrete structures	C	Eduardo FAIRBAIRN	Miguel Ângelo Dias AZENHA	2013	❖
255	FRS	Fire resistance of concrete structures repaired with polymer cement mortar	C	Takafumi NOGUCHI	Kei-Ichi IMAMOTO	2013	

Active TCs at a glance

TC NUMBER	TC ACRONYM	TC TITLE	CLUSTER	TC CHAIR	TC DEPUTY CHAIR	ACTIVITY STARTED IN	TC CLOSED IN MARCH 2019
256	SPF	Spalling of concrete due to fire: testing and modelling	C	Pierre PIMIENTA	Robert McNAMEE	2013	
269	IAM	Damage assessment in consideration of repair/retrofit-recovery in concrete and masonry structures by means of innovative NDT	C	Tomoki SHIOTANI	Dimitrios AGGELIS	2016	
273	RAC	Structural behaviour and innovation of recycled aggregate concrete	C	Jianzhuang XIAO		2015	
	IEC	Impact and explosion	C	Marco DI PRISCO	Ezio CADONI	2018	
258	AAA	Avoiding alkali aggregate reactions in concrete - performance based concept	D	Børge J. WIGUM	Jan LINDGARD	2014	
259	ISR	Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reactions	D	Victor SAOUMA	Leandro SANCHEZ	2015	
263	EEC	Environmental evaluation of concrete structures toward sustainable construction	D	Amnon KATZ	Guillaume HABERT	2012	
270	CIM	Benchmarking chloride ingress models on real-life case studies: theory and practice	D	Eddie A. B. KOENDERS	Kei-ichi IMAMOTO	2016	
	CCH	Stress corrosion cracking and hydrogen embrittlement of concrete-reinforcing steels	D	Javier Sanchez MONTERO	Alvaro RIDRUEJO	2016	
	DCM	Long-term durability of structural concretes in marine exposure conditions	D	Kefei LI	Junjie ZENG	2019	
	SHE	Self-healing concrete – its efficiency and evaluation	D	Feng XING	Erik SCHLANGEN	2016	
245	RTE	Reinforcement of timber elements in existing structures	E	Jorge BRANCO	Philipp DIETSCH	2011	
250	CSM	Composites for sustainable strengthening of masonry	E	Gianmarco DE FELICE	Daniel OLIVEIRA	2012	❖
271	ASC	Accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization	E	Barbara LUBELLI	Inge RORIG-DALGAARD	2016	
274	TCE	Testing and characterisation of earth-based building materials and elements	E	Jean Claude MOREL	Antonin FABBRI	2016	
277	LHS	Specifications for testing and evaluation of lime-based repair materials for historic structures	E	Ioanna PAPAYIANI	Jan VALEK	2017	
	IMC	Durability of inorganic matrix composites used for strengthening of masonry constructions	E	Antonietta AIELLO	Catherine PAPANICOLAOU	2019	
264	RAP	Asphalt pavement recycling	F	Gabriele TEBALDI	Eshan V. DAVE	2015	
272	PIM	Phase and interphase behaviour of bituminous materials	F	Emmanuel CHAILLEUX	Christiane RAAB	2016	
278	CHA	Crack-healing of asphalt pavement materials	F	Hassan BAAJ	Orazio BAGLIERI	2016	
279	WMR	Valorisation of waste and secondary materials for roads	F	Lily POULIKAKOS	Bernhard HOFKO	2017	
280	CBE	Multiphase characterisation of cold bitumen emulsion materials	F	Andrea GRAZIANI	Alan CARTER	2017	

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Cluster A:
Material Processing and Characterization

Foreword from Cluster A Convener, **Barzin MOBASHER**

I have been a member of RILEM for the past 16 years, however I started as a participant in various RILEM conferences and sponsored workshops at least a decade prior to that.

My participation in two RILEM Technical Committees 201-TRC State of the Art Report on Textile Reinforced Concrete and 232-TDT led by late Professor Brameshuber has had a lasting impact on my career. I joined RILEM TAC in 2011 and became the convener of Cluster A in 2014. In this process, I have learned so much more about the inner working and functions of the committees that has helped me tremendously in serving other organizations as well.

Cluster A constitutes a broad range of areas dealing with the chemistry, characteristics, microstructure, and physical properties of a wide range of materials addressed under the auspices of RILEM technical committees. The TCs in this Cluster range from the characterization of supplementary cementitious materials, to the characterization of quasi-brittle fracture.

The level of professional dedication of the cluster members in developing new test methods, conducting and testing interlaboratory tests, and development of tools for a better understanding of the materials places us at the forefront of many recent developments in the construction materials industry and academia.

The guidelines, state of the art documents, and the test methods developed are routinely used and adopted by other organizations and researchers as a testament to the quality of work conducted. It is truly an honour to be working with such a class of RILEM researchers from around the world who dedicate so much energy to produce documents that serves our industry, infrastructure, and development of new recommendations for characterization of new and exciting concrete and cement-based materials.

It is interesting that before the work of a committee is about to complete, the working of the committee members culminates with proposals for continuation of work through the next generation of committee and the members of the TC gladly volunteer to continue their efforts.

The colleagues I have interacted have become very close personal friends, colleagues, collaborators and mentors. The names are far too many. It is the continued interactions with such colleagues that makes this organization one of the most delightful career experiences I have had and I look forward to a more fruitful future.

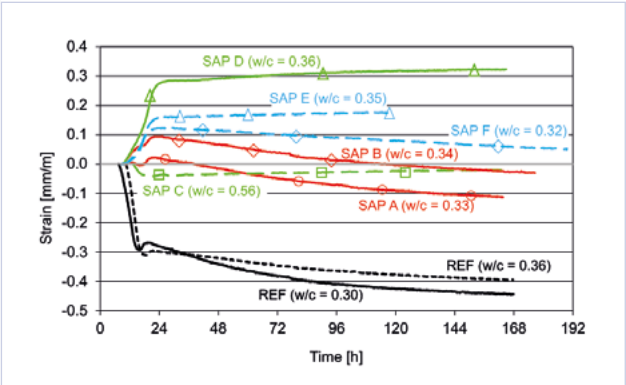
260-RSC: Recommendations for use superabsorbent polymers in concrete construction

Chair: Viktor MECHTCHERINE // Deputy chair: Mateusz WYRZYKOWSKI

Activity started in 2014

Significance

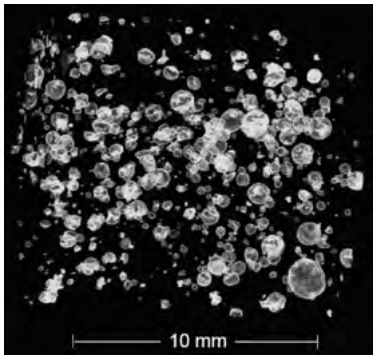
- Superabsorbent Polymers (SAP) have proven to be effective in improving concrete properties (decrease in autogenous and plastic shrinkage, increase in freeze-thaw resistance, etc.).
- A considerable gap still exists between laboratory experience and application in the praxis of construction.



▲ *Effect of SAP addition on autogenous shrinkage of concrete.* Courtesy of Viktor Mechtcherine.

Relevance

- Clear guidelines are needed on a purposeful choice of type and dosage of SAP as well as on the consideration of interactions of SAP with other chemical admixtures and the effects of SAP addition on workability and mechanical properties of concrete.



◀ *CT image of SAP void distribution in hardened cement paste.* Courtesy of Viktor Mechtcherine.

Goals

- To trigger application of SAP in concrete construction.
- To find answers to open questions related to practical use of SAP.
- To come up with recommendations for practitioners.

Methodology

- Collecting and evaluating relevant articles, data and expert opinions.
- Preparing joint publications on the state-of-the-art in the field.
- Developing standard testing procedures for SAP prior to use in concrete.
- Performing round-robin test to investigate the effect of SAP addition on plastic shrinkage
- Publishing recommendations on 1) testing sorption behaviour of SAP, 2) use of SAP to mitigate autogenous shrinkage, and 3) use of SAP to improve freeze-thaw resistance.

Progress

- Wyrzykowski M. et al. (2018) Recommendation of RILEM TC 260-RSC: using superabsorbent polymers (SAP) to mitigate autogenous shrinkage, *Materials and Structures*, 51:135.
- Snoeck D. et al. (2018) Recommendation of RILEM TC 260-RSC: testing sorption by superabsorbent polymers (SAP) prior to implementation in cement-based materials, *Materials and Structures*, 51:116.
- Mechtcherine V. et al. (2017) Effect of superabsorbent polymers (SAP) on the freeze–thaw resistance of concrete: Results of a RILEM interlaboratory study, *Materials and Structures*, 50: 14.
- Schröfl C et al. (2017) A review of characterisation methods for superabsorbent polymer (SAP) samples to be used in cement-based construction materials: Report of the RILEM TC 260-RSC, *Materials and Structures*, 50:197.
- Mechtherine V et al. (2018) Testing SAP characteristics prior to implementation in concrete: Results of a RILEM round-robin test, *Materials and Structures*, 51:28.

261-CCF: Creep behaviour in cracked sections of fibre reinforced concrete

Chair: Pedro SERNA // Deputy chair: Sergio CAVALARO

Activity started in 2014

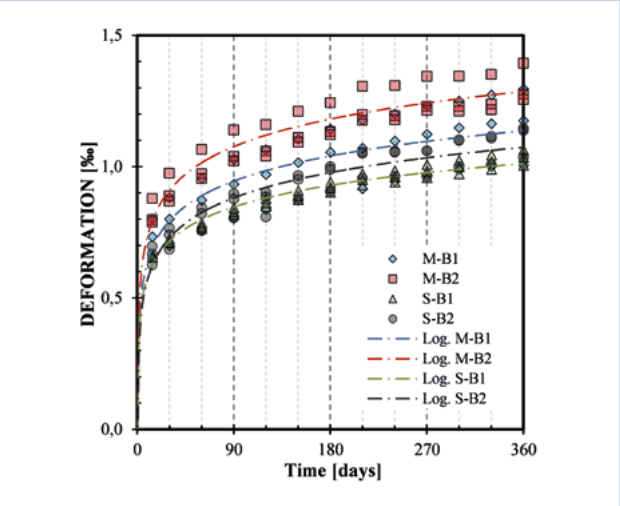
Significance

- Codes include guidelines for the design of fibre reinforced concrete (FRC) structures but still lack recommendations on how to consider creep of FRC cracked sections.
- There is no standard method for the experimental assessment of creep in FRC cracked sections.

▲ *Flexural creep of FRC prismatic specimens.*
Courtesy of Pedro Serna.

Relevance

- The growth in FRC structural applications is currently hindered by the limited knowledge and absence of consensus regarding the importance and the impact of creep on the performance of FRC structures.



▲ *Creep test result in the round robin test.*
Courtesy of Pedro Serna.

Goals

- Coordinate research efforts and compile results on the creep of FRC cracked sections.
- Create consensus about the importance of creep depending on the application
- Propose unified test methods to assess the FRC creep behaviour, clarifying the criteria to analyse the test results.
- Evaluate the variables that influence creep behaviour of cracked sections of FRC

Methodology

- Collect and evaluate relevant articles, data and expert opinions.
- Prepare joint publications on the state-of-the-art in the field.
- Perform round-robin test to investigate different test methods.
- Develop a standard testing procedure to assess creep of FRC cracked sections.
- Promote academic and technical knowledge around the outputs derived from the technical committee.

Progress

- Organisation of the International RILEM Workshop on Creep Behaviour in Cracked Sections of Fibre Reinforced Concrete held at Valencia (Spain) on March 9th-10th, 2016.
- Publication of FRC-CREEP 2016 RILEM Book series.
- Execution of round-robin test about the experimental procedure to assess creep in FRC cracked sections that included 18 laboratories around the world.
- Preparation of State-of-the-Art Report on Creep (to be completed by 2020).
- Preparation of the RRT report and of recommendation for the experimental procedure to assess creep of FRC cracked sections (to be completed by 2019).

266-MRP: Measuring rheological properties of cement-based materials

Chair: Mohammed SONEBI // Deputy chair: Dimitri FEYS

Activity started in 2015

Significance

- Measuring rheological properties of cement-based materials is a complicated task which can include many errors.
- Different rheometers deliver different results for the same mix design, and the reasons behind these differences are currently unknown.
- Uniform recommendations and guidelines on how to perform rheological testing and analysis are missing.

Relevance

- Since the introduction of more flowable concrete mixtures, and with the recent developments in the field of additive manufacturing, the importance of rheology in our field has increased tremendously.
- Mastering rheological measurements of cement-based materials is a steep learning curve, and requires experience and guidance to judge the quality of the measurements.
- Further developments in applying rheology in the construction industry can be hindered by the lack of understanding on how to perform measurements.

Goals

- The TC intends to provide a state-of-the-art report on different aspects of measuring rheological properties of cement-based materials, including a discussion on the main rheological properties, types of rheometers, rheological models and measurement artefacts.
- Based on this STAR, the TC will also develop a set of guidelines or best-practices.
- A measurement campaign comparing different concrete rheometers was performed in May 2018 in Bethune, France.

Methodology

- The main methodology of the TC is to compile existing literature and expert opinions.

Courtesy of Mohamed Sonebi.

Progress

- Feys D. et al. (2017) Measuring rheological properties of cement pastes: most common techniques, procedures and challenges, *RILEM Technical Letters*, 2:129-135.
- Proceedings of the International RILEM Workshop on Rheological Measurements of Cement-based Materials, IRWRMC'18, Edited by C. Djelal & Y. Vanhove, RILEM Publications, s.a.r.l., 2019.
- STAR is expected to be ready for review by the end of 2019.
- The data from the concrete rheometer comparison campaign is being analysed by all parties involved. A paper has been submitted to SCC2019 in Dresden to discuss the results in September 2019, and a reunion of the team members is being organized for November 2019 to share the findings with all interested parties. Several publications are anticipated.
- Based on the STAR and expert opinions, recommendations will be prepared in 2020.
- TC-266 sponsored with ACI236/ACI237/ACI552 two technical ACI sessions on Innovations in SCC Rheology (March 2017) and Concrete and Digital Fabrication: Perspectives, Challenges and Developments, Oct. 2017.

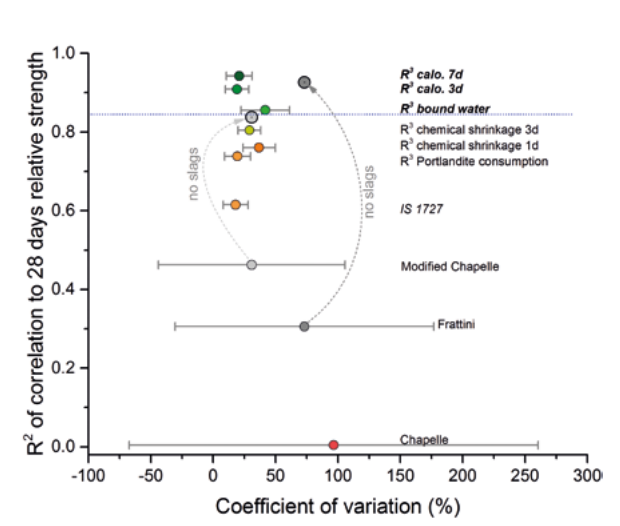
267-TRM: Tests for reactivity of supplementary cementitious materials

Chair: Karen SCRIVENER // Deputy chair: Ruben SNELLINGS

Activity started in 2015

Significance

- Supplementary cementitious materials (SCMs) are commonly used in concrete, either in blended cements or as separate additions into the concrete mixture.
- Their use is one way to obtain a more sustainable binder with additional benefits (cost and durability).
- There is a lack of methods to assess the reactivity potential (not only pozzolanic) of a material for use as an SCM.



LiX. et al. (2018).

Relevance

- The testing and optimisation of straightforward SCM reactivity test protocols, based on measurement of SCM properties that can be related in a straightforward way to performance in cement and concrete materials.

Goals

- Propose SCM reactivity test protocols designed to correlate with strength development, for conventional hydraulic and pozzolanic materials including coal combustion fly ash and natural pozzolans, ground granulated blast furnace slags and calcined clays.

Methodology

- Phase 1 (2016-2017): Comparison and benchmarking of SCM reactivity tests.
- Phase 2 (2017-2018): Optimisation of most promising test methods.
- Phase 3 (2019-2020): Validation and definition of scope of optimized finalized test protocols.

Progress

- Li X. et al. (2018) Reactivity tests for supplementary cementitious materials: RILEM TC 267-TRM phase 1, 2018. *Materials and Structures* 51, 151.
- Snellings R. et al. (2019) A rapid robust and relevant R3 reactivity test for supplementary cementitious materials. *ACI Materials*, Special Edition (in press).
- Dissemination in pre-conference workshops and doctoral courses: i. Cement Characterisation course 4/2017, EPFL, Lausanne; ii. LC3 course 4/2018, EPFL, Lausanne; iii. Pre-normative and standardization work: Balloting of R3 test protocols by ASTM; iv. Highlighting of TC 267 TRM work in Cement and Concrete Research Special Edition reviews.

275-HDB: Hygrothermal behaviour and durability of bio-aggregate based building materials

Chair: Sofiane AMZIANE // Deputy chair: Florence COLLET

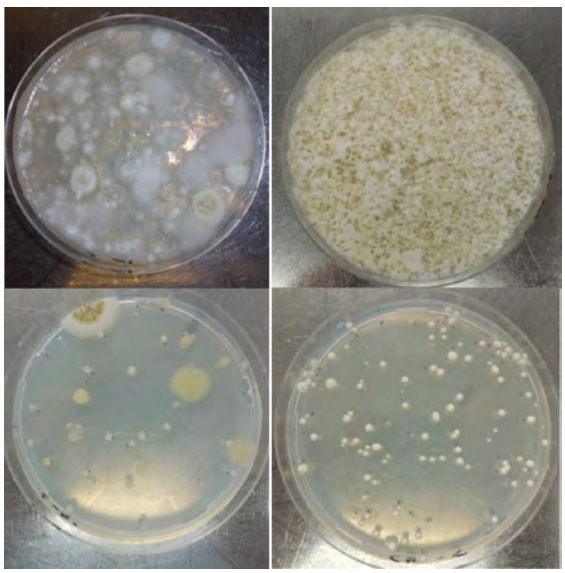
Activity started in 2016

Significance

- The preservation of the environment is one of the principal features of sustainable development with the urge to reduce Green House Gas (GHG) emissions.
- The construction sector battles four main impacts on the environment: GHG emissions; energy consumption; consumption of natural resources; waste production.
- Plant based materials have a valuable benefit for health, for providing ecologic, comfortable habitat (moisture management, thermic and acoustic) and sustainable materials.

Relevance

- Bio-based building materials have proven to have both viability and marketability in the construction industry, despite their relative infancy, but limited research has been carried out.
- Their natural abilities to absorb carbon dioxide and to act as good thermal and acoustic insulator are the motivations for further research.



PH impact on mould growth. Courtesy of Sofiane Amziane.

TC memebers on 14th November 2018 at VICAT premises: distribution of specimens. Courtesy of Sofiane Amziane.

Goals

- Organize during two years (2019/2020) a round robin test (RRT) on vegetal concrete specimens.
- Assess the properties of vegetal concrete exposed to different types of aging in laboratory.
- The expected outcomes are the production of an updated version of the STAR published in 2017 and the presentation of the main outputs at the fourth ICBBM, Barcelona 2021.

Methodology

- A RRT to compare the protocols in use by the different laboratories to measure density of specimens, thermal conductivity, Moisture Buffering Value (MBV), water vapour transfer parameter and durability parameters.

Progress

- After 5 meetings in 2017/2018, the RRT started in 2019 and will be concluded by a conference and publication of the results in 2021.

276-DFC: Digital fabrication with cement-based materials

Chair: Nicolas ROUSSEL // Deputy chair: Dirk LOWKE

Activity started in 2016

Significance

- "Digital fabrication" means "turning some digital data into a cement-based object without the use of a standard formwork".
- These emergent new construction processes translate into extended freedom for shaping and designing but also into questions concerning rheological target requirements, kinetics of hardening and new processing technologies.
- A community that links and connects the many teams around the world developing 3D printing techniques and opening digital fabrication laboratories does not exist.

Gala Dinner of the 1st RILEM International Conference on Concrete and Digital Fabrication (2018). Courtesy of Nicolas Roussel.

Relevance

- The validation and publication of the work produced by this TC will be crucial to academics, testing laboratories, industrialists and Ph.D. students for further expansion of research in this field.
- Society will benefit from the outcomes of this TC as cement-based digital fabrication is being proven to be economically and environmentally more sustainable than other building techniques.

Goals

- Gather information on materials and rheological properties, processes such as extrusion techniques, particle bed techniques, advanced slip forming and other patented technologies.
- Create a database of examples of applications and cases studies along with a process classification.
- It is expected that this topic will attract new RILEM members.

Courtesy of 3DCP Research Group.

Methodology

- This TC shall base its output on the outcomes of previous TCs such as TC-SCF and TC-MRP.
- The TC will organize conferences and workshops on digital construction.

Progress

- International workshop on Digital Fabrication with Concrete (2017) ETH Zurich, ETH Hönggerberg (Switzerland), 13 January 2017.
- 2nd International RILEM Workshop on Rheology and Digital Fabrication of Cement-based Materials (2017) Brunel University London (UK), 9 June 2017.
- Workshop: 3D manufacturing technologies in construction (2017) Faculty of Architecture and the Built Environment, TU Delft (the Netherlands), 21 November 2017.
- Digital fabrication in construction industry: Italian case studies (2018), see figure.
- 1st RILEM International Conference on Concrete and Digital Fabrication (2018) ETH Zurich, ETH Hönggerberg (Switzerland), 9-12 September 2018.

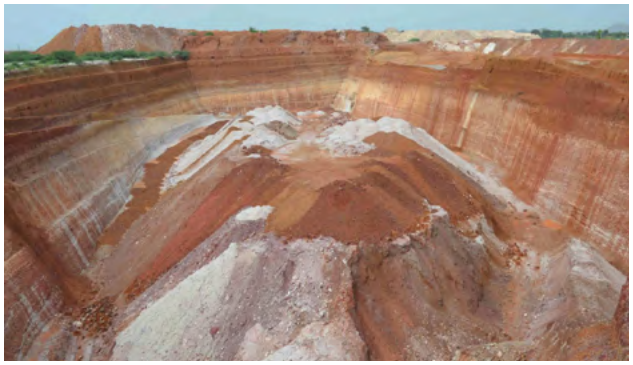
282-CCL: Calcined clays as supplementary cementitious materials

Chair: José Fernando MARTIRENA-HERNANDEZ // Deputy chair: Manu SANTHANAM

Activity started in 2018

Significance

- The reduction of steel production and phasing out of coal power plants has reflected in a significant decrease in the supply of common Supplementary Cementitious Materials (SCMs) like fly ash and slag.
- The scarcity of these SCMs has prompted the use of calcined clays as an alternative.
- There is a need to pave the way for a wider usage of this material to achieve sustainability in cement production.



Calcined clay quarry. Courtesy of Manu Santhanam.

Methodology

- The work will be focused on every issue related to the use of kaolinitic clays for the production of reactive pozzolans through their thermal activation and their use in cement manufacture.
- This includes clay mineralogy, geology of clay deposits, the use of calcined clays in portland-calcined clay and Portland-calcined clay limestone systems, hydration and performance of calcined clays in cementitious systems.

Clay calciner in Cuba. Courtesy of Fernando Martirena.

Relevance

- The work of this TC will enable a wider use of an abundantly available material and its incorporation in today's practice for cement manufacture and use.
- Academics, scientists from industry and members of standard committees will benefit from the outcomes of this TC.

Goals

- To produce recommendations for characterization of suitable clays for the production of reactive calcined clays and for the process of clay calcination.
- To publish a State of the Art Report on the use of calcined clays in cementitious systems.
- To organise workshops to communicate findings to standardisation communities.

Progress

- Kick-off meeting held in Delft 2018, during the 72nd RILEM Annual Week.
- Two meetings planned in 2019.
- 35 registered members.

AMC: Use of agro-based materials as cementitious additions in concrete and cement-based materials

Chair: Said KENAI // Deputy chair: Mike OTIENO

Activity started in 2018

Significance

- Agro-based materials are renewable materials that can reduce the construction industry greenhouse emissions and negative impact on the environment.
- Lack of industrial applications.

Courtesy of Said Kenai.

Relevance

- Clear guidelines are needed to promote the use of these materials in the construction industry in developing countries.
- Promote the use of these materials in some industrial applications.

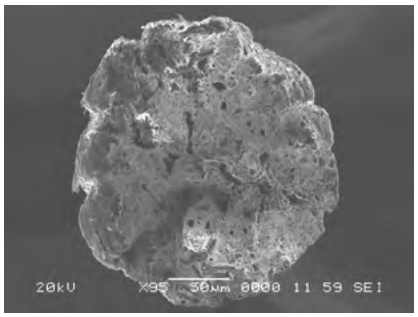
▲
Stipa tenacissima (Alpha) fibres.
Courtesy of Said Kenai.

Goals

- Promote the use of agro-based materials.
- Come up with recommendations for the construction industry.

Methodology

- Review available data and produce state of the art report on the use of agro-based materials in cement and concrete.
- Building a shared database on agro-based materials in developing countries.
- Publish recommendations on some of these materials.
- Perform Round Robin tests.



▲
Alpha fiber transversal section.
Courtesy of Said Kenai.

Progress

- This TC was established in September 2018.
- The kick-off meeting was held in Nairobi, Kenya, on 31 January-1 February 2019.

CEC: Controlled expansion of concrete by adding MgO-based expansive agents taking the combined influence of composition and size of concrete elements into consideration

Chair: Jiaping LIU // Deputy chair: Ole Mejlhede JENSEN

Activity started in 2018

Significance

- MgO-based expansive agents have proven to be effective in compensating shrinkage and mitigating cracking of concrete, and their effect can be controlled by regulating the reactivity and micro-structure.
- In addition to the characteristics of MgO itself, the composition and size of concrete element also have strong influence on expansion of concrete with MgO-based additives, which is still not fully understood.

Cracking and leakage of underground wall due to shrinkage.
Courtesy of Jiaping Liu.

Relevance

- Clear guidelines on quality control methods and the choice of reactivity and dosage of MgO will be of particular interest for practitioners who are involved in design and building of reinforced concrete structures with high crack resistance, and for producers of expansive agents to improve the quality of their products.

Goals

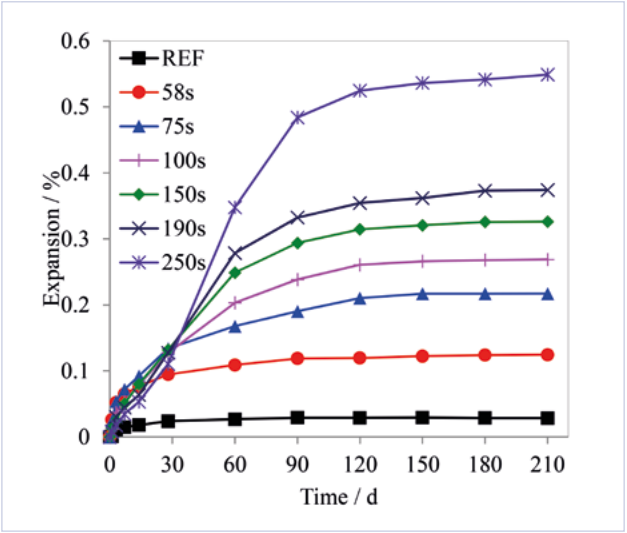
- To reach a better understanding of the expansion of concrete after addition of MgO based expansive agents.
- To give guidelines for practical applications of MgO-based expansive agent.
- To reduce the risk of crack formation by well-designed and controlled concrete expansion.

Methodology

- Preparing state-of-the-art report in the field
- Developing standard testing procedures for quality control of MgO and property evaluation of concrete with MgO additives
- Carrying out the round-robin test series in at least five laboratories
- Developing a prediction model for the expansion of concrete with MgO
- Preparing and publishing a guideline for practical applications of MgO in concrete

Progress

- Kick-off meeting held during the 72nd RILEM Annual Week in Delft, the Netherlands, in 2018.
- Next meeting scheduled during the 73rd RILEM Annual Week in Nanjing, China, in 2019.



Effect of 5% MgO addition on expansion property of cement pastes under 40°C water curing.
Courtesy of Jiaping Liu.

RILEM
TECHNICAL REPORT

Cluster B: Transport and Deterioration Mechanisms

Foreword from Cluster B Convener, **Esperanza MENENDEZ**

From having only 4 clusters, in October 2006 the number of TC Clusters was increased to 5. Cluster B was at that time renamed to "Transport and Deterioration Mechanisms", with Prof. Nele De Belie (Belgium) as Convener. From September 2015, I have taken over as Cluster B Convener.

Cluster B on *Transport and Deterioration Mechanisms* is related to the properties of the construction materials and their chemical, physical, mechanical and durability behaviour. The use of traditional and novel construction materials is conditioned by their properties. The service life of the structures is conditioned by these properties in addition to the environmental and exposure conditions. Many aspects have been analysed by the TCs. Some properties of traditional construction materials have been studied. Furthermore, many innovative materials are studied in these TCs, like for instance recycled building materials, alkali-activated materials, super-absorbent materials in construction, etc. Also, durability aspects and combination of actions are studied, for example, sulfate attack, chloride ingress or actions of microorganism. These technical committees are related mainly to cement based materials, pastes, mortars and concretes.

Between 2005 and 2019, 21 Technical Committees have been created under Cluster B. These TCs are related with different aspects of traditional and novel construction materials, their properties and the durability behaviour.

With respect to the production of these TCs, around 14 documents have been published since 2006. These include State-of-the-Art Reports, Recommendations and other technical publications.

247-DTA: Durability testing of alkali-activated materials

Chair: John L. PROVIS // Deputy chair: Frank WINNEFELD

Activity started in 2012

Significance

- Alkali-activated materials (binders, mortars and concretes; collectively, AAMs) are potentially environmentally beneficial construction materials.
- Their durability has been identified as being a key issue for their development.
- The majority of existing durability testing methods have been developed specifically for application to the chemistry of portland cement binder systems.
- Some standard test protocols have been identified as being either sub-optimal or entirely unsuitable for application to the analysis of AAM durability.

Courtesy of Parichat Cheechana.

Relevance

- Academics, testing laboratories, regulators, industrialists, and practitioners will all be able to make use of the insight into testing methods provided by the TC.
- The results will be published openly for direct use by regulators and practitioners.
- Society will benefit (both economically and environmentally) from the potential reductions in CO2 emissions which may be achieved through the use of alkali-activated binders.

Goals

- The primary aim of this TC is to indicate the appropriateness of existing test methodologies and protocols for the analysis of the durability of AAMs.
- Steel corrosion is the most important performance parameter which needs to be understood, and this TC aims to connect the testing methodologies to the likely effects observed in terms of steel corrosion in service.

Methodology

- Five working groups will deliver a set of recommendations based on round-robin tests of standardised alkali-activated material mix designs.
- This TC will address the key scientific questions with particular reference to Chloride penetration, Carbonation, Sulfate attack, Freeze-thaw/frost-salt processes, and Alkali aggregate reactions.

Progress

- Round-robin testing: completed!
- Three papers currently in preparation or under review (Materials and Structures).

251-SRT: Sulfate resistance testing

Chair: Véronique BAROGHEL-BOUNY // Deputy chair: Esperanza MENENDEZ MENDEZ

Activity started in 2013

Significance

- Little is known about external sulfate attack when dealing with new concrete mixtures.
- The appropriate tools for prediction of external sulfate attack are not yet available.
- Resistance to such an attack is therefore a key challenge for structural durability.
- Existing testing procedures related to external sulfate attack are not appropriate. More research is needed on this topic to better understand and capture the degradation occurring in the field.
- A more inclusive assessment of surface damage, including both expansive (scaling) and softening or disintegration types of destruction, is required.

Courtesy of Esperenza Menendez Mendez.

Relevance

- Academics, testing laboratories, regulators, industrialists and practitioners will all be able to make use of the recommendations provided by this TC.
- The results will favour the safe use of «green» materials by ensuring their durability to ESA.

Goals

- Better understanding of the degradation mechanisms not only involved in lab tests but also occurring in real conditions (e.g. mechanical effects will strongly depend on the size/type of test specimen).
- Gathering field results and/or relevant information from trials in field conditions on exposure sites.
- Providing recommendations regarding appropriate test methodology and protocols for the analysis of external sulphate resistance.

Methodology

- This TC will analyse the possible combination with other sources of degradation (cases of seawater, including e.g. competition between chlorides and sulfates in both the transport and the binding process with the cement matrix, dry climates, …).
- This TC will also study the specific aspect of thaumasite (e.g. temperature aspect), keeping in mind that thaumasite formation is a «second event» of classical external sulfate attack.
- Suggestions for future Round Robin Tests will be provided, in order to investigate the role of some parameters, as well as to assess repeatability/reproducibility of the proposed test methods.

Progress

- State-of-Art Report in preparation
- Lisbon 2016 Workshop, Proceedings published by LNEC
- Madrid 2018 RILEM Workshop, Proceedings will be published in August 2018 by Springer
- Drafting of RILEM Recommendation, including proposal for set of test methods, in preparation.

253-MCI: Microorganisms-cementitious materials interactions

Chair: Alexandra BERTRON // Deputy chair: Henk JONKERS

Activity started in 2013

Significance

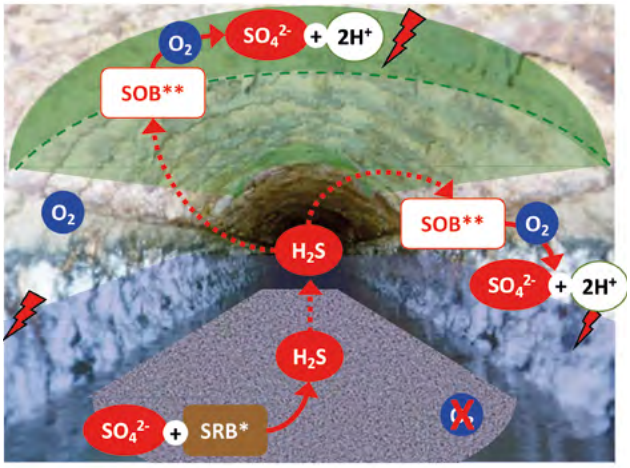
- Structures can suffer deleterious action of microorganisms (biodeterioration) in a variety of contexts (sewer networks, agricultural plants, tunnels, etc.). The aesthetics of buildings can be altered by microbial stains. Microorganisms' proliferation on indoor materials is responsible for health issues worldwide.
- Engineered bacteria-based systems are being developed to protect and/or repair cementitious materials (self-healing systems).
- Concerted approaches need to be implemented to move toward a better understanding of these phenomena and propose relevant test methods.

Relevance

- Significant increase in the cost of repairing structures or cleaning of facades, to loss of production income, to pollution issues, etc. due to biodeterioration. Very important economic and societal consequences of bacterial proliferation inside buildings.
- Bacteria based-healing can improve durability, environmental impact profiles and economics of cement-based materials
- Practitioners, owners, architects, material and product manufacturers, scientists, standardization committees, etc. will be using the deliverables of this committee.

Goals

- To provide better knowledge on biological environments and their aggressiveness.
- To help with the understanding of microorganisms-cementitious materials interaction mechanisms in the various contexts.
- To propose relevant performance test methods for concrete or bacteria-based systems.



*SRB : Sulfate-reducing Bacteria
**SOB : Sulfur-oxidizing Bacteria

Courtesy of Matthieu Peyre Lavigne.

Methodology

- Creation of international collaborative network to progress in the various topics.
- Critical literature review carried out to clarify and summarize current knowledge in the form of a State-of-the-Art report.
- A dozen of meetings and two international conferences organised during the TC life.

Progress

- Wiktor H. et al. (2016) International RILEM Conference on Microorganisms-Cementitious Materials Interactions, RILEM ed., Proceedings 102. Delft, p. e-ISBN: 978-2-35158-160-5: 170.
- Bertron A. and Jonkers H. (2018) Proceedings of RILEM TC 253 MCI Microorganisms-Cementitious Materials Interactions, RILEM ed., Proceedings PRO 123. 2 Volumes, e-ISBN: 978-2-35158-207-7: 593.
- Bertron A. et al. (2017) Biodeterioration of concrete in agricultural, agro-food and biogas plants: state of the art and challenges. *RILEM Technical Letters* 2:83-89.
- STAR, State-of-the-Art Report - Publication expected in 2020.

262-SCI: Characteristics of the steel/concrete interface and their effect on initiation of chloride induced reinforcement corrosion

Chair: Ueli ANGST // Deputy chair: Mette GEIKER

Activity started in 2014

Significance

- Local conditions at the steel/concrete interface, better known as "defects" or "irregularities", are key parameters for corrosion initiation, but little is known on their possible effect on chloride-induced corrosion initiation.
- This lack of fundamental understanding hampers the development of reliable predictive models for corrosion in concrete.

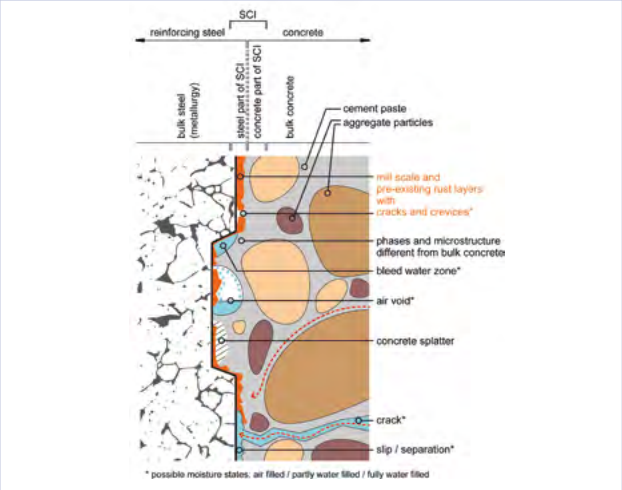
Courtesy of Ueli Angst.

Relevance

- The targeted group of users is primarily researchers as the findings of the TC promotes scientific discussion in the field of corrosion of steel in concrete.
- On the long term a better understanding of corrosion initiation in concrete will be useful to owners of infrastructure, testing laboratories and consulting engineers, and may also have an impact on the practice of assessing the condition of existing, chloride-exposed structures and predicting their service life.

Goals

- Categorizing different conditions at the steel/concrete interface and their possible effect on chloride-induced corrosion initiation. in order to elucidate the most pronounced influencing factors.
- Give guidance for the direction of future research in corrosion of steel in concrete.
- Summarizing existing methods to determine the conditions at the steel/concrete interface.



Angst U. et al. (2017).

Methodology

- In addition to bibliographical research, the committee work consists in exchange of experience and results, including unpublished results.

Progress

Between June 2015 and March 2019, in total 13 TC meetings were held and two publications were prepared:

- Angst U. et al. (2017) The steel-concrete interface, Materials and Structures, 50: 143.
- Angst U. et al. (About to be submitted to Materials and Structures) The effect of the steel-concrete interface on chloride-induced corrosion initiation in concrete.

281-CCC: Carbonation of concrete with supplementary cementitious materials

Chair: Nele DE BELIE // Deputy chair: Susan BERNAL-LOPEZ

Activity started in 2017

Significance

- Carbonation induces a drop in alkalinity which disrupts the protective passivation layer on embedded steel and causes corrosion.
- SCM concrete exhibits high carbonation susceptibility. A deeper understanding of chemical and transport phenomena and of the influence on corrosion are needed.
- In standard carbonation tests, effects of mechanical loads are not accounted for.
- Prediction models for carbonation-induced corrosion need to be adapted for concrete containing SCMs.

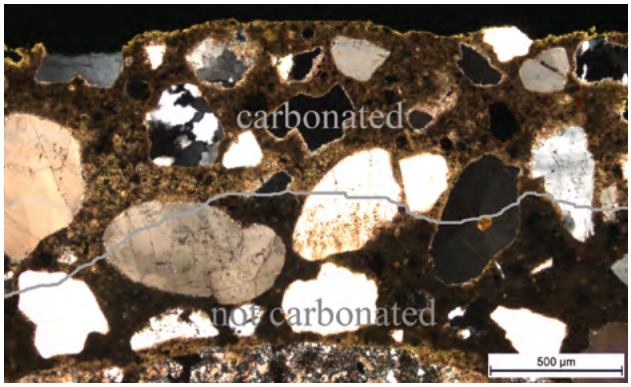
Courtesy of Hanne Vanoutrive and Elke Gruyaert.

Relevance

- Researchers and industry want to rapidly and reliably assess concrete durability, but accelerated tests with increased CO2 concentration may alter the carbonation process.
- Carbonation of concrete with SCMs and alkali-activated concrete is an important consideration for practitioners.

Goals

- Assess the effects of carbonation on phase assemblage under accelerated and natural carbonation conditions for SCM concrete, including alkali-activated systems.
- Determine changes in mineralogy, microstructure and transport properties as a function of carbonation degree.
- Quantify the effect of mechanical loads on carbonation resistance.
- Optimize models for carbonation-induced steel depassivation in blended and alkali-activated binder concrete to achieve a more accurate service life prediction.



Courtesy of Philip Van den Heede.

Methodology

- Critically review existing literature.
- Run an inter-laboratory comparison of accelerated carbonation tests.
- Develop standardized test setups for combined carbonation and load.
- Publish the findings in journals and prepare recommendations.

Progress

- Three meetings were held in 2018-2019, incl. a 2-day workshop, and 6 working groups have been established.
- A one day special session was organised during the RILEM spring convention in Rovinj, March 2018.
- A review paper on factors influencing carbonation is drafted.
- An inter-laboratory test comparing different standardized approaches for accelerated carbonation is currently launched.

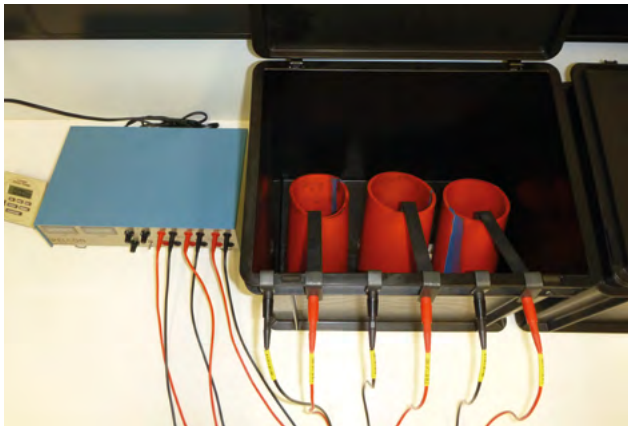
283-CAM: Chloride transport in alkali-activated materials

Chair: Arnaud CASTEL // Deputy chair: John PROVIS

Activity started in 2018

Significance

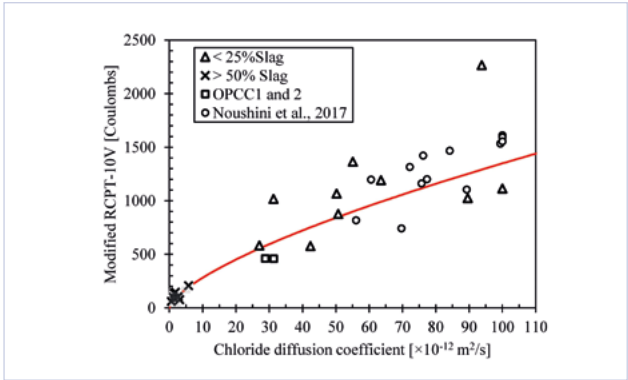
- Alkali-Activated Materials (AAMs) are a sustainable alternative to Portland cement.
- The lack of standard specification is one of the main barriers for Alkali-Activated Materials (AAMs) adoption by the industry.



Courtesy of Arnaud Castel.

Goals

- Reducing barriers for commercial adaptation of AAMs through the development of performance-based specifications.
- Adapt/recalibrate existing testing methods (ASTM C1556, ASTM C1202, NT BUILD 492) to be used to assess AAMs performance in chloride environments.
- Develop chloride diffusion models for AAMs.



Courtesy of TC 283-CAM.

Relevance

- TC CAM outcomes will be of interest for researchers who are interested in understanding chloride-related durability of AAMs and Industrial end-users who are seeking to specify AAMs.
- TC CAM will address key questions related to the rate and mechanisms of chloride transport in AAMs, with a view toward drafting Recommendations and Performance-Based Specifications for chloride environments.

Methodology

Three working groups as following:

- WG1: Performance based specifications for AMMs.
- WG2: Chloride binding capacity of AAMs.
- WG3: Service life prediction/modelling chloride penetration in AMMs.

In addition, TC CAM aims to compare both laboratory results and simulations to data obtained from analysis of samples placed in the field under service conditions.

Progress

- TC established in November 2018, with kick-off meeting held at Polytech Nice Sophia Antipolis (France).
- First meeting during the 2nd RILEM Spring Convention, Rovinj (Croatia) in March 2019.
- Second meeting planned during the ICCC congress in Prague in September 2019.

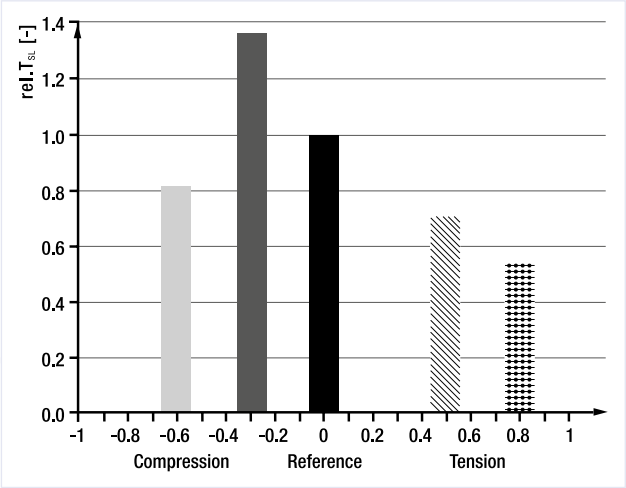
FTC: Durability and service life of concrete under the Influence of freeze-thaw cycles combined with chloride penetration

Chair: Folker H. WITTMANN // Deputy chair: Peng ZHANG

Activity started in 2018

Significance

- The influence of combined environmental actions and mechanical load on durability and service life of reinforced concrete structures has been studied in detail by RILEM TC 246-TDC with Professor Yao Yan as Chairperson. A bibliography and a Recommendation for appropriate test series was published.
- RILEM TC FTC is one of the necessary follow-up TCs.
- So far the influence of environmental actions and mechanical load are considered separately. In this way service life is not realistic, it is overestimated.



Relative service life of unloaded concrete members (reference) and identical concrete members under the influence of compressive and tensile stress. Courtesy of Folker Wittmann.

Relevance

- Service life of existing reinforced concrete structures is in too many cases not sufficient.
- Expensive repair measures are frequently necessary at an early age of structures.
- In many countries, necessary repair must be postponed because of financial problems.
- This serious problem can be solved only by more realistic service life design.

Goals

- Service life of reinforced concrete structures under the influence of freeze-thaw cycles and chloride penetration is shorter than service life under the two actions separately. This reduction of service life shall be determined.
- A modification of standards for service life prediction shall be proposed.

Methodology

- A comprehensive literature review shall be set up and published. Then comparative test series shall be run in different laboratories. All results shall be critically analysed.
- Finally, practical recommendations for more realistic service life prediction shall be published.
- Work shall be carried out in close cooperation with other RILEM TCs in which other load combinations will be studied.

Progress

- A comprehensive literature review is now being set up by members of the TC. This document shall be finalized during the first TC meeting and then published. The first meeting of the TC is planned to be held in Nanjing, China, during the coming RILEM week. During this meeting the first comparative test series shall be planned.

TMS: Test method for concrete durability under combined role of sulphate and chloride ions

Chair: Changwen MIAO // Deputy chair: Geert De SCHUTTER

Activity started in 2018

Significance

- Aggressive processes of combined sulphate and chloride attack are rather complex for reinforced concrete.
- Under the combined role of sulphate and chloride containing water, service life of reinforced concrete structures can be shortened considerably.

Courtesy of Mu Song.

Relevance

- National standardizing agents.
- Building materials testing laboratories.
- Construction companies.
- Design offices, and related government agencies.

Courtesy of Mu Song.

Goals

- To develop a standardized test method.
- To quantify the influence of environmental factors and mechanical load on the corrosion of steel bars and deterioration of concrete.
- To determine time dependent changes of the microstructure and transport properties of concrete.
- Possible measures to increase service life of reinforced concrete structures.

Methodology

- Literature review on degradation mechanisms.
- Experimental programs for testing chloride penetration in presence of sulphate ions.
- Comparative test series to observe combined sulphate and chloride migration into concrete.
- Evaluation and discussion of test results and necessary improvement of the test method.
- Finalizing the test method and drafting of recommendations.

Progress

- Kick off meeting during 73rd RILEM Annual Week in Nanjing, August 2019.
- Until now, about 2000 square meters exposure site of salty soil in Gan Su, province of northwestern China, has been built by an industry partner of Prof. Miao and it will be probably used for the research activities of the TC.

GDP: Test methods for gas diffusion in porous media

Chair: Bruno HUET // Deputy chair: Philippe TURCRY

Activity started in 2019

Significance

- The gas diffusion coefficient is a general indicator of the resistance to gas transfer of a given microstructure of a porous medium.
- Different methods for measuring gas diffusion coefficient of cementitious materials have been developed but no technical consensus exists on those methods.
- In the future, gas diffusion could be used as specific indicator of cement-based building material performance.

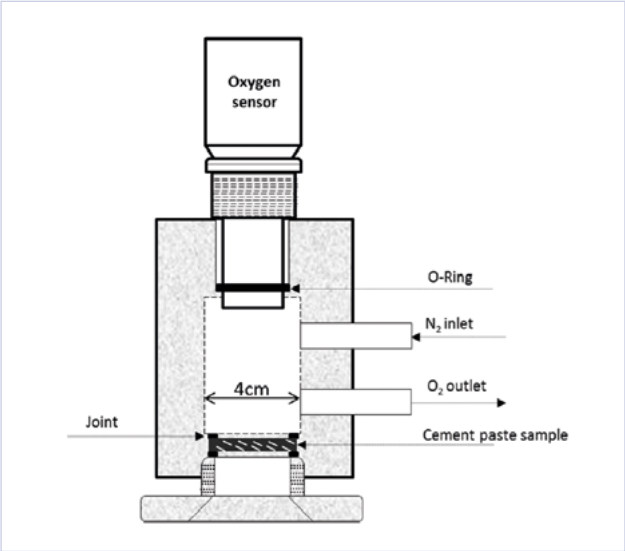
Relevance

- The results of this TC will deliver experimental evidence and state of knowledge useful for the definition of future standards. In particular, they will be of interest to technical bodies of the European committee for standardisation (CEN): CEN/TC104/SC1 focusing on concrete performance and CEN/TC 51/WG 12 focusing on special performance criteria
- Published documentation could also serve as a reference technical documentation for laboratories (academics, industries, service companies) when developing their own setup.

Goals

The TC will deliver the following achievements:

- a state-of-the-art report addressing the relevance of gas diffusion, the physical principles, the various test methods, factors influencing measurements, a compilation of available data and examples of applications;
- a testing campaign on inert porous materials and reference cementitious materials;
- a comparison of existing test methods with source of uncertainties;
- an harmonized method of analysis to calculate gas diffusion from raw experimental measurements;
- summary of TC findings in one or more journal publications;
- an international workshop for dissemination of information.



Oxygen diffusion cell sketch. Boumaaza et al. (2018).

Methodology

- Collecting information on existing gas diffusion tests is a key task. Thus, the first efforts of the TC will focus on a state of the art review.
- Not many labs are currently equipped with gas diffusion test methods. Therefore a benchmark of methods on reference inert materials and non-ageing cementitious materials is proposed.
- Works will be conducted to assess the effect of low pressure difference gradient for each test method, resulting from the setup or multi-species diffusion.
- A strategy will be defined to evaluate the range of measurement (i.e. upper and lower limits), and it could be affected by the cell design, sample geometry and RH conditioning.

RILEM
TECHNICAL REPORT

Cluster C: Structural Performance and Design

Foreword from Cluster C Convener, **Giovanni PLIZZARI**

Material and structural behaviour are closely connected since the optimization starts from structural performance which significantly depends on material behaviour. Indeed, structural behaviour should carefully look at material performance as well as material behaviour to be oriented to a better structural response.

For this reason RILEM activated Cluster C which coordinates the activities of the Technical Committees (TCs) dealing with "Structural Performance Design".

Currently, in the Cluster five TCs are active in impact and explosion (IEC), damage assessment in consideration of repair-retrofit-recovery (269-IAM), fire spalling (256-SPF), fire resistance (255-FRS) and structural behaviour of recycled aggregate concrete (273-RAC).

Structural behaviour should be supported by reliable numerical models that are particularly useful for better understanding structural behaviour as well as for structural design. Therefore, TCs active in "numerical modelling" of materials and structures are an important component of Cluster C as it may use experimental data to better predict structural performance.

The first TC belonging to Cluster C was established in 1996 and it was "*175-SLM: Computer bases on service life methodology*". Since then, 23 TCs have worked under the coordination of the convener of Cluster C, service that I have the honour to hold since 2018 after Prof. Takafumi Noguchi.

The first recommendation published by this Cluster dates back to 1997, "Recommendations of RILEM TC 178-TMC: '*Testing and modelling chloride penetration in concrete*' Analysis of water soluble chloride content in concrete". Four more recommendations and seven state-of-the-art-reports (STARs) have been published since then by the TCs belonging to Cluster C.

244-NUM: Numerical modelling of cement-based materials

Chair: Klaas VAN BREUGEL // Deputy chair: Patel RAVI

Activity started in 2011

Significance

- Lack of knowledge about material models used in design codes, guidelines and recommendations may lead to confusion, misinterpretation, unsafe design and poor predictions of short- and long-term performance of concrete structures.
- Clarity about the background of materials models is vital for sound engineering designs, as well as for fair competition in the bidding phase of construction projects.

Relevance

- In modern types of contracting contractors take the responsibility for both the structural safety and the long-term performance of their structures. For that purpose they need knowledge about the background and applicability of the models they use.
- For a justified use of alternative (environmental friendly) binders, the applicability of currently used materials models for cement-based materials need reconsideration.

Goals

A STAR will be provided, dealing with the following topics:

- Explaining the need for in-depth understanding of the background of models;
- General characterisation of currently used numerical models for materials properties used in design codes;
- Identification of dominant materials parameters and providing recommendations for improvements and/or modifications of currently used materials models.

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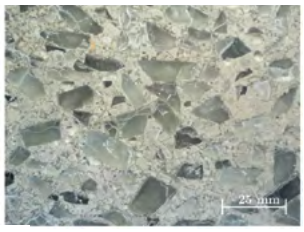

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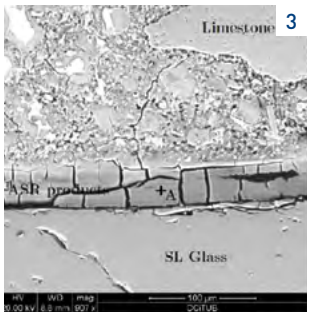


3

▲
1. >10^{-1}m
2. >10^{-3}m
3. >10^{-4}m
Courtesy of TC 244-NUM.

Methodology

The structure of the STAR dictates the activities of the TC. It contains the following topics:

- An introduction on the need of in-depth knowledge of materials models and modelling;
- A characterisation of material models used in codes and identification of future needs;
- An overview on the potential of advanced models on meso-, micro- and nano-level;
- A concluding chapter on multiscale modelling and an outlook.

Progress

TC-244 NUM will finish its activities in August 2019. The main deliverable of TC-244 NUM is a STAR on numerical models of properties of cement-based materials. The publication of the STAR is foreseen after the RILEM week in Nanjing in 2019. No decision has been made yet on a special event on the occasion of the publication of the final STAR.

249-ISC: Non-destructive in-situ strength assessment of concrete

Chair: Denys BREYSSE // Deputy chair: Jean-Paul BALAYSSAC

Activity started in 2012

Significance

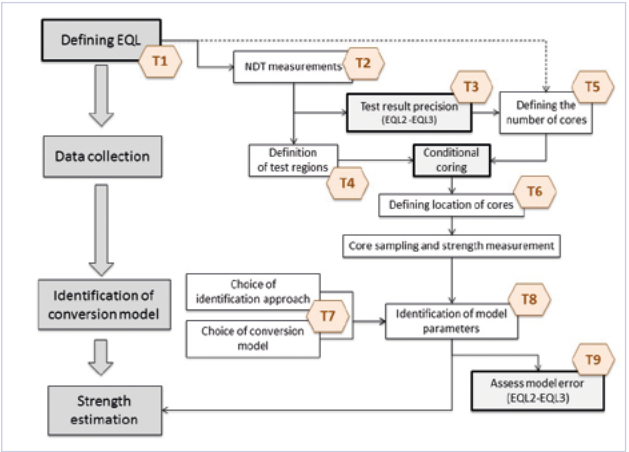
- Non-destructive techniques (NDT) are used to estimate the concrete strength in existing structures without significant damage.
- Recent works in academic research have identified that the common assessment methodology suffers many weaknesses and have suggested ways for improving it.

Relevance

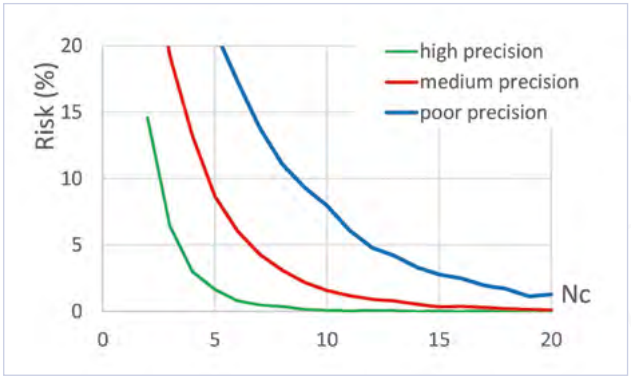
- Clear guidelines are needed describing all steps to follow in order to improve the reliability of the concrete assessment process.
- They must rely on a limited number of cores (destructive tests) and provide ways of quantifying the reliability of the assessment.

Goals

- Based on engineer's expertise and real databases, identify the most important factors that govern the reliability of the assessment process and quantify their effect.
- Address the issue of mean strength, local strength and overall variability in concrete structures.



Flowchart of the recommended process, with key tasks.
Courtesy of Denys Breysse.



Risk-curves defining the number of cores.
Courtesy of Denys Breysse.

Methodology

- Main issues were:
  - o the definition of the assessment target (EQL) and its tolerance interval,
  - o the quantification of the precision of ND test results, and
  - o he definition of location of cores on the basis of a previous NDT screening.
- All conclusions were drawn after checking on real datasets and synthetic datasets.

Progress

- Detailed Guidelines with practical examples will be published (2019) in a Springer book.
- Breysse D. et al. (2017) Nondestructive assessment of in situ concrete strength: comparison of approaches through an international benchmark, *Materials and structures*, 50: 133.
- Breysse D. and Balayssac J.P. (2018) Strength assessment in reinforced concrete structures: From research to improved practices, *Construction and Building Materials*, 182: 1-9.

254-CMS: Thermal cracking of massive concrete structures

Chair: Eduardo M. R. FAIRBAIRN // Deputy chair: Miguel AZENHA

Activity started in 2013

Significance

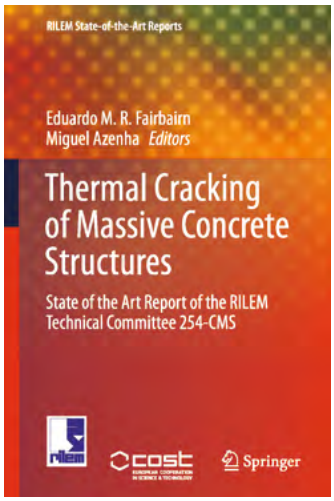
- Thermal cracking of massive concrete structures is an important phenomenon originated by the hydration reaction of the cementitious materials.
- There have been several recent developments related to the old problem of the stresses originated from the evolution of concrete hydration.
- Having identified that there was a lack in the organization of scientific and technological knowledge about cracking at the early ages, it was decided to undertake an in-depth study of the recent developments on this subject.

Relevance

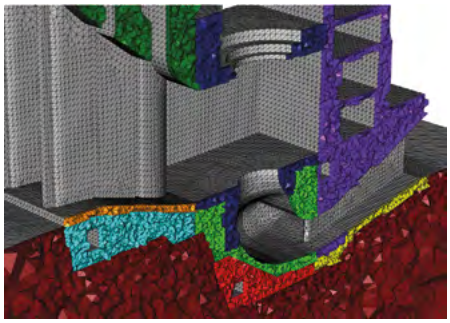
- In practice, it happens that several massive concrete structures such as hydroelectric and nuclear power plants, thick foundations, bridge pier columns and caps, thick walls, tetrapods breakwaters, etc., may experience cracking at the early ages due to restrained thermal deformations. Therefore, the construction phase and the period that follows it should be accurately analysed.

Goals

- Establish a state-of-the-art-report (STAR) on principles, criteria, methods and technology applied worldwide to control thermal cracking in mass concrete.
- Application to concrete dams, nuclear power plants, massive foundations and massive members of concrete structures.
- Follow up on the development of guidelines on how to analyse and control the risk of thermal cracks of concrete. As a first step of this work, write papers that will support developments.



◀ *Springer 2018.*



Courtesy of Eduardo Fairbairn.

Methodology

- Use of web platforms or conference calls to perform on-line meetings (roughly half of the meetings).
- Bibliographical research and exchange of experience and results, including unpublished results.

Progress

- Thermal Cracking of Massive Concrete Structures – State of the Art Report of the RILEM Technical Committee 254-CMS (2019) Edited by Eduardo Fairbairn, Miguel Azenha, Springer.
- The STAR was published by Springer in 2018.
- 6 web meetings, 9 presence meetings and 1 workshop.
- 6 papers are being prepared with joint work and case studies.
- A follow-up committee is being planned.

255-FRS: Fire resistance of concrete structures repaired with polymer cement mortar

Chair: Takafumi NOGUCHI // Deputy chair: Kei-Ichi IMAMOTO

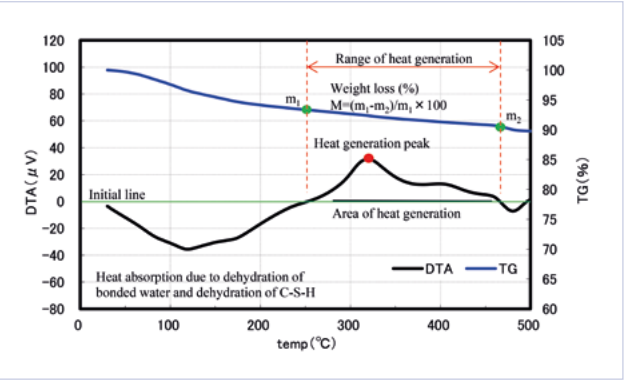
Activity started in 2013

Significance

- Polymer cement mortar (PCM) is currently used in large quantities as a popular repair material for the deteriorated reinforced concrete.
- The existence of polymer might reduce the fire preventive performance of the cement mortar and concrete, which sometimes causes the spalling of the PCM (see picture).
- There is the need of a deeper fundamental understanding of the mechanisms of spalling of PCM under fire and of the mechanical properties of reinforced concrete members repaired with PCM.

Relevance

- The outcomes of this TC will be beneficial for academics, test laboratory workers, industrialists and practitioners.
- Extending the lifetime of concrete means safer and more durable structures.
- Best practices related to the study of concrete with PCM will lead to new materials and practices.



▲ *Exothermic peak area is a key indicator of fire resistance.*
Courtesy of Takafumi Noguchi.

Goals

- Developing a deeper fundamental understanding of the mechanisms of spalling of PCM under fire and of the mechanical properties of reinforced concrete members repaired with PCM.
- Establish test methods to evaluate their fire resistance.

Courtesy of Takafumi Noguchi.

Methodology

- This TC will conduct scholarly activities on the following areas:
  - o Properties of PCM: Thermal conductivity, Thermal expansion coefficient, Mechanisms of spalling, Fire resistance, Mechanical properties at high temperature.
  - o Structural behaviour of RC members repaired with PCM: flexural performance of beams and slabs, structural performance of columns, method to keep the bond between PCM and structural concrete, prevention method for fire spalling of concrete structures.
  - o Test methods: Incombustibility of PCM, spalling resistance of PCM, fire resistance.

Progress

- STAR "Fire Resistance of Concrete Structures Repaired with Polymer Cement Mortar" currently being reviewed by TC members and will be hopefully published in 2019.
- Main outcomes of TC will be presented at the 73rd RILEM Annual Week in Nanjing, China, in August 2019.

256-SPF: Spalling of concrete due to fire: testing and modelling

Chair: Pierre PIMIENTA // Deputy chair: Robert McNAMEE

Activity started in 2013

Significance

- Spalling is the sudden ejection of concrete on the exposed surface of structural elements exposed to fire which can significantly reduce the fire resistance of the structure.
- Although this phenomenon has been studied for several decades, it remains an active topic of investigation due to the complexity of the physical mechanisms involved.
- No consensus exists on how to assess concrete spalling.
- No model can predict the phenomena properly.

Relevance

- Recommendations of the new TC on test methods will allow a better comparison of international results.
- Results from testing laboratories will be better harmonized.
- Report on modelling will constitute a guideline for research works.
- All the actors (construction owners, manufacturers…) will benefit from the outcomes of the TC owing the improvements of the safety.

Goals

- To publish a State-of-the Art on fire spalling of concrete.
- To establish recommendations on experimental methods for characterizing fire spalling and connected properties (e.g. concrete water content).
- To publish examples of the consequences of spalling phenomena on the fire resistance and residual capacities of different types of concrete structures.
- To help improving accuracy of models by analysing their key parameters.

Spalling phenomena observed inside a furnace during a laboratory fire test.
Courtesy of Robert McNamee.

Spalling observed after a fire in a parking garage.
Courtesy of Robert McNamee.

Methodology

The TC has 52 active members and is organised in 5 Tasks:

- Task 1: State of the Art of concrete spalling under fire;
- Task 2: Influence on fire resistance and residual capacity;
- Task 3: Experimental methods for assessing concrete fire spalling;
- Task 4: Modelling of spalling phenomenon;
- Task 5: Round-robin tests (provided funding).

Progress

- 4th "International Workshop" on October 8th and 9th, 2015, organized by MFPA (Prof. Frank Dehn) and the RILEM TC as Scientific Committee.
- 5th "International Workshop" on October 12th and 13th, 2017, organized by RISE (Dr. Lars Boström), Brandskyddslaget (Dr. Robert McNamee) and the RILEM TC as Scientific Committee.
- Next 6th "International Workshop" on September 19-20, 2019, organized by Sheffield University (Dr. Shan-Shan Huang) and the RILEM TC as Scientific Committee.

269-IAM: Damage assessment in consideration of repair/retrofit-recovery in concrete and masonry structures by means of innovative NDT

Chair: Tomoki SHIOTANI // Deputy chair: Dimitrios AGGELIS

Activity started in 2016

Significance

- Worldwide infrastructure is aging. By 2030 more than half of the roads and bridges will be older than 50 years.
- Proper condition evaluation and maintenance is essential.
- Nowadays maintenance is mostly "reactive" after serious damage is evident. There is an urgent necessity to change this to "proactive".

Courtesy of Tomoki Shiotani.

Relevance

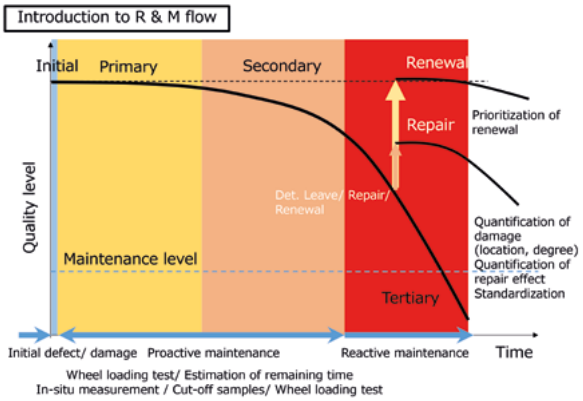
- Infrastructure safety is of paramount importance for humans to avoid casualties.
- Limited budget calls for assessment of the condition before prioritization of the decision which structure to repair/ maintain first.
- Proactive maintenance and repair require less budget than repair of large-scale damage.
- Construction and maintenance industries, owners/managers of infrastructure, a broad range of stakeholders are relevant to the scope of the TC.

Goals

- Exploration of effective NDT techniques. Quantification of the repair effect.
- Improvement of reliability of repair and monitoring methods.
- Establish life cycle scenarios considering repair improvement as obtained by NDT techniques.
- RILEM recommendations and recommended practices for quantification of repair/ reinforcement works by NDT.

Methodology

- Study of repair practices in different countries.
- Separate in "task forces" focused on:
  1. Survey (suitable NDT methods)
  2. Evaluation of initial damage
  3. Evaluation of repair
  4. Life cycle management in relation to 3



Courtesy of Tomoki Shiotani.

Progress

- Six meetings have been organized. Separation in task forces is under way.

273-RAC: Structural behaviour and innovation of recycled aggregate concrete

Chair: Jianzhuang XIAO

Activity started in 2015

Significance

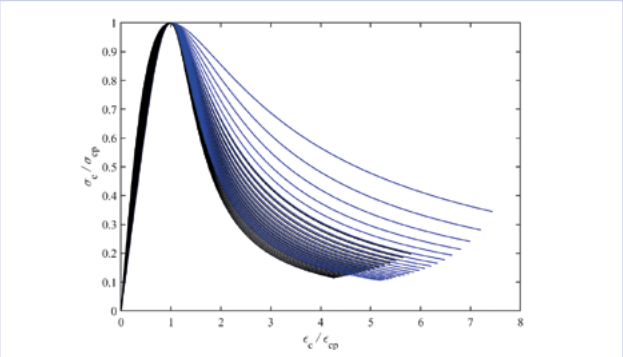
- Construction and Demolition (C&D) waste encompasses a very broad range of materials, characterized by significantly different relevant properties.
- The properties of RAC should be improved to efficiently facilitate the effective reuse of RCA especially in structural components.
- The reuse of C&D waste materials in the construction industry needs adequate technical means to promote their worldwide employment.

Relevance

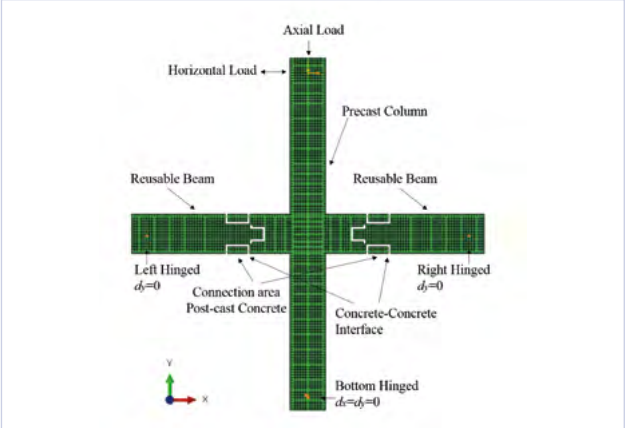
- Members of industry or researchers involved in the field of sustainability, recycling of materials for structural use, will promote them for further investigation.
- Producing guidelines for engineers, architects and practitioners to use these materials at a daily basis to promote sustainability.

Goals

- To predict and improve the mechanical properties of structural recycled concrete.
- To encourage the transfer of TC's findings to practitioners through the publication based on the given four points:
- Component behaviour
- Case-studies in structural RAC
- Code or Guidelines
- Monitoring and numerical simulation models for practical design



Courtesy of Jianzhuang Xiao.



Courtesy of Jianzhuang Xiao.

Methodology

- To validate the RAC for structural purposes, by experiments and simulations and comparing them with the data for regular concrete and monitoring on-site.
- Performing tests to investigate the effect of RCA addition on mechanical behaviour and long-term properties of RAC.
- Analysing the existing standards and specifications of RA and/or RAC.
- Publishing recommendations/codes and specifications on the mix proportion and structural design of RAC.

Progress

- Xiao et al. (2018) A recycled aggregate concrete high-rise building: Structural performance and embodied carbon footprint, *Journal of Cleaner Production*, 199.
- Xiao et al. (2018) Variability of stress-strain relationship for recycled aggregate concrete under uniaxial compression loading, *Journal of Cleaner Production*, 181.

IEC: Impact and explosion

Chair: Marco DI PRISCO // Deputy chair: Ezio CADONI

Activity started in 2018

Significance

- In the framework of impact and explosion, there are many specific experimental devices all over the world, which have never been thoroughly compared and connected.
- There is the need to develop a stronger link between the worldwide existing experimental laboratories that have specific devices, often not fully used.
- At present, there is no interaction between activities by national, regional and international associations (fib, ACI, etc.).
- A joint committee RILEM-fib working on the chapter "Impact and Explosion" of the fib Model Code 2020 can contribute to revitalize the RILEM association as "Labs link" and not only as "Experts link", fully rediscovering its original mission.

Relevance

- The targeted users are researchers, practitioners and standardization bodies in the field of concrete technology.

Goals

- To coordinate a database of the special devices oriented to investigate Impact and Explosion effects on materials and structures;
- To introduce the state-of-the-art knowledge in the specific Model Code 2020 chapter aimed at guiding the designers to quantify the bearing capacity of conventional structures to these specific actions;
- To propose and compare test methods to determine the parameters characterizing the high strain rate (or better loading rate) behaviour depending on the specific structure;
- To analyse the variables which more affect the structural effects when subjected to these actions;
- To develop new practical recommendations and design criteria.

RILEM-fib group in the last meeting on 12th March 2019, in JRC Ispra (III meeting).
Courtesy of Marco Di Prisco.

Barajas Airport, Terminal T4 Parking Building - 30th December, 2006.
Courtesy of Alejandro Pérez Caldentey.

Methodology

- Preparation of a first meeting in Milan by the end of May in order to discuss the index of Model Code 2020 and to distribute the chapters among the participants.
- In the second year of activities, the working group will be aimed at the preparation of a RILEM/fib/ACI Workshop that could converge in a workshop organized in Vancouver.
- In the two following years, the Committee will achieve the last three main objectives.

Progress

- Three meetings held so far: Kick-off meeting in July 2018 in Politecnico di Milano; 2nd meeting in November 2018 in Madrid (Fhecor Company), 3rd meeting in March 2019 in JRC Ispra.

RILEM
TECHNICAL REPORT

Cluster D: Service Life and Environmental Impact Assessment

Foreword from Cluster C Convener, **Alexandra BERTRON**

Cluster D coordinates the activities of the Technical Committees (TCs) dealing with "Service life" and "environmental impact" of structures, mainly reinforced concrete structures. These are key-areas of research and without any doubt, some of the most discussed topics today in all sectors, from finance to engineering to mention a few.

At the moment, the Cluster comprises seven TCs. The topics covered by these TCs vary from alkali-silica reactions to chloride ingress and stress corrosion cracking, from loss of serviceability evaluation, development of performance-based approaches of concrete design, to environmental analysis. The originality and the richness of the TCs' works lie in the fact that they often combine literature reviews, on-site experimental campaigns and/or modelling of service life assessment.

The first TC belonging to Cluster D was established in 1998 and it was "*183-MIB Microbial impacts on building materials – weathering and conservation*". Since then, 22 TCs have worked under the coordination of the convener of Cluster D, title that I have the honour to hold since 2016. I took over the role previously filled by Professor Kefei Li.

The first recommendation published by this Cluster dates back to 2000, "*RILEM TC 191-ARP 'Alkali-reactivity and prevention - Assessment, specification and diagnosis of alkali-reactivity' AAR-5: Rapid preliminary screening test for carbonate aggregates*". Nine state-of-the-art-reports (STARs) have been published over the life span of Cluster D.

258-AAA: Avoiding alkali aggregate reactions in concrete - performance based concept

Chair: Børge Johannes WIGUM // Deputy chair: Jan LINDGÅRD

Activity started in 2014

Significance

- Alkali Aggregate Reactions (AAR) decrease the service life of concrete structures.
- Performance based testing concept, where alkali reactive aggregates and potential safe cementitious binders are combined, will ensure durable concrete structures and enable use of local reactive aggregates.
- Accelerated laboratory performance tests, along with potential alkali-release from aggregates, need to be verified with results from outdoor exposure sites.

Relevance

- A reliable performance testing concept is crucial for enabling the aggregate, cement and concrete producers to optimise their products in a sustainable way, securing durable concrete structures for benefit of the society.

Goals

- Develop and promote a performance based testing concept for the prevention of deleterious AAR in concrete structures.
- Strong emphasis will be put on the implementation of the RILEM methods and recommendations as national and international standards.

Expansion measurement at an outdoor exposure site. Courtesy of Børge Johannes Wigum.

Alkali-silica gel extruded from reacted concrete. Courtesy of Jan Lindgård.

Methodology

The work is divided in four Work Packages (WPs):

- WP1 – Development of accelerated laboratory performance tests.
- WP2 – Comparison of laboratory results to field behaviour, i.e. vs. field exposure sites.
- WP3 – Assessment of detailed alkali inventory in concrete (literature survey) and development of an accelerated test for alkali release from aggregates.
- WP4 – Verification of the Performance Testing Concept.

Progress

- Four papers (open access) published in Proceedings of international Conference on Concrete Repair, Rehabilitation and Retrofitting (ICCRRR2018), Cape Town, South Africa. Paper numbers: 03001, 03002, 03004 and 03006.
- Three papers (open access) published in Proceedings of international Conference on Sustainable Materials, Systems and Structures (SMSS2019), Rovinj, Croatia, PRO 128 "Durability, Monitoring and Repair of structures", Section "Avoiding alkali aggregate reactions". Paper pages 144, 152 and 168.

259-ISR: Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reaction

Chair: Victor SAOUMA // Deputy chair: Leandro SANCHEZ

Activity started in 2014

Significance

- Our lives critically depend on civil infrastructure on an everyday basis.
- A large number of critical structures built in the past decades worldwide are reaching their expected service lives besides showing major signs of deterioration.
- Action is needed to ensure adequate performance or even to extend the lifespan of critical aging infrastructure.

Relevance

- Alkali-aggregate reaction (AAR) is one of the most harmful distress mechanisms affecting the durability and serviceability of concrete infrastructure worldwide.
- One of the current biggest challenges while dealing with aging infrastructure is to identify the cause and the extent of damage (i.e. diagnosis), to establish the correlation between the reductions in mechanical properties, physical integrity and performance of the affected material, to evaluate possible structural implications and also the potential for further deterioration (i.e. prognosis). Those are critical steps in the selection of management actions of aging infrastructure.

Goals

The premise of our TC is to appraise current damage caused by AAR in existing concrete structures and to forecast their potential of further deterioration through the use of:

- Proven/validated finite element (FE) codes to perform a suitable predictive analysis;
- Laboratory tests able to diagnose and prognose AAR in the laboratory;
- NDE techniques aiming to assess the extent of AAR deterioration.

Courtesy of Victor Saouma.

Methodology

259-ISR committee is divided into four work groups (WG):

- WG1: Testing methods;
- WG2: Numerical modelling;
- WG3: Non-destructive testing;
- WG4: Nuclear power plants and dams.

Courtesy of Leandro Sanchez.

Progress

- The 259-ISR committee should complete its activities by the fall 2019.
- State-of-the-Art reports (STAR) are targeted for WG1, WG3 and WG4, whereas WG2 is expected to publish its findings in the *Materials and Structures* journal.

263-EEC: Environmental evaluation of concrete structures toward sustainable construction

Chair: Amnon KATZ // Deputy chair: Guillaume HABERT

Activity started in 2012

Significance

- Environmental assessment of concrete structures requires special attention due to the large number of items to be addressed: proper definition of the functional unit, allocation of impacts regarding by-products, the large amount of materials used for concrete manufacture as well as concrete service life issues. Thus, its implementation can create a large variability between simulations.

Relevance

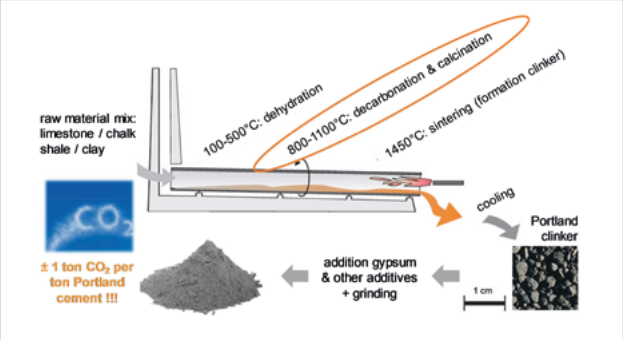
- Output of this committee is useful for LCA practitioners. These LCA practitioners can be industrials or stake-holders dealing with the environmental evaluation of concrete.
- This information will also be useful for academics that are not familiar with LCA and want to learn which parameters are fundamental and must be considered.

Goals

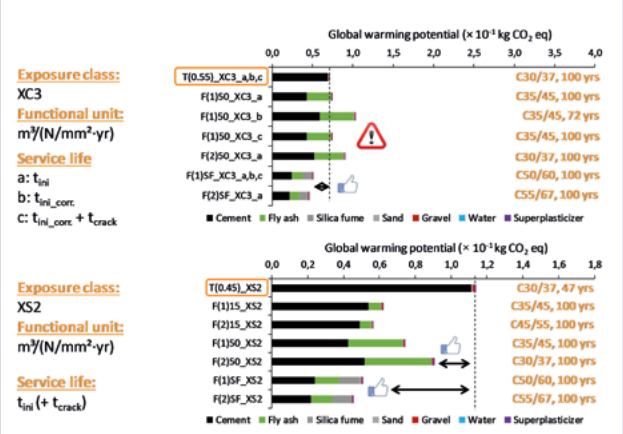
- The objective of this committee is to highlight the main parameters which have a critical influence on the environmental parameters of concrete structures (not the whole building) and are therefore fundamental to pay attention to during an environmental evaluation.
- This TC will allow strengthening the LCA results in order to help environmental evaluation to be used in public decisions.

Methodology

- Resolving questions related to the system boundary definition including detailed aspects of sensitivity of the results to varying system boundaries.
- Evaluation of the consequences, in term of LCA, of durability differences between concrete types (rather than on service life studies per-se).



Courtesy of Philip Van den Heede.



Courtesy of Philip Van den Heede.

Progress

- The committee had several meetings in the past. A draft version of a short STAR was prepared.

270-CIM: Benchmarking chloride ingress models on real-life case studies: theory and practice

Chair: Eddie A. B. KOENDERS // Deputy chair: Kei-Ichi IMAMOTO

Activity started in 2016

Significance

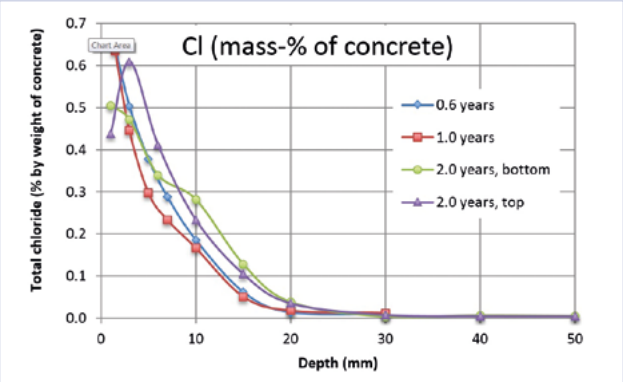
- There is a strong need to benchmark the performance of the currently available models for simulating the ingress of chlorides into the concrete cover.
- The proposed benchmark may serve as a reference tool for calibrating current and future generations of chloride ingress models.

Relevance

- Enhancing the prediction accuracy of chloride ingress models will support the entire group of users, i.e. academia, consultancy, industry, governmental bodies, etc. to assess the service life of concrete infrastructure more reliably.
- A significant economic impact will result, based on the fact that the benchmark will provide more insight in the usability, accuracy and reliability of chloride ingress models that are used for the future performance and associated maintenance needs.

Goals

- Benchmarking analytical and numerical based models on typical marine and road spray cases;
- Defining calibration methods for the input data represented by two real life cases.
- Come up with official RILEM recommendations for practitioners.



Courtesy of L. O. Nilsson.

Courtesy of Tang Luping.

Methodology

- Identifying and selecting currently available engineering- and/or scientifically-based models used for chloride ingress calculations.
- Select and define two typical case studies for benchmarking;
- Simulate the chloride ingress with engineering and/or scientifically based models and list analyse the performance.
- Identify potential gaps in model accuracies, differences, coverages and model limitations.

Progress

- Benchmarking case studies have been performed on marine submerged and road spray cases; Results have been analysed and discussed.
- Chapters have been defined and are under development.
- The TC is still on schedule and a STAR and RILEM recommendations are planned for 2020.
- Koenders E.A.B., Modelling of chloride ingress in concrete based on benchmarking field results, MATEC Web of Conferences 199, 01005 (2018) (open access).

CCH: Stress corrosion cracking and hydrogen embrittlement of concrete-reinforcing steel

Chair: Javier SANCHEZ MONTERO // Deputy chair: Alvaro RIDRUEJO

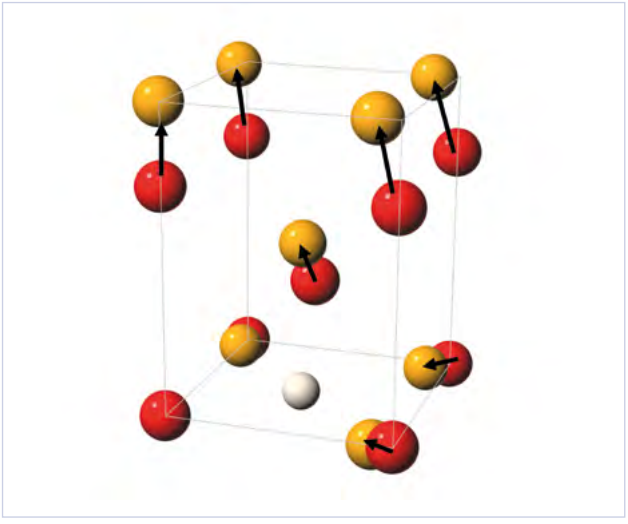
Activity started in 2016

Significance

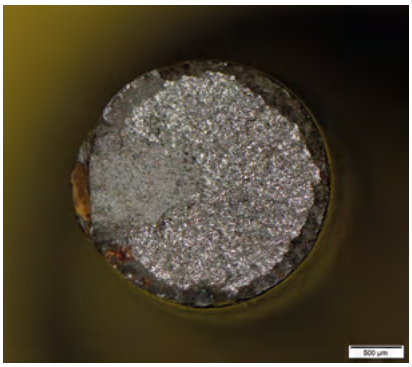
- Corrosion is the main cause of structure degradation. Prestressed structures often suffer from Environment Assisted Cracking (EAC), triggered by two main phenomena: Stress Corrosion Cracking (SCC) and Hydrogen Embrittlement (HE).
- The chemical, mechanical and physical aspects of SCC and HE have not been satisfactorily explained.
- There is no general agreement on testing methods for the study of SCC.
- Understanding the chemical and physical properties of hydrogen inside the iron lattice would help to control and prevent the cracking of steel.

Relevance

- The targeted group of users is primarily researchers.
- The outcomes of this TC will also be useful to consulting engineers to estimate the durability and assess the condition of structures under aggressive environments.



Courtesy of Javier Sanchez.



Courtesy of Javier Sanchez.

Goals

- To produce a state of the art report that will comprise a compilation of the main mechanism of SCC and HE applied to prestressing steels.
- The report will also include a compilation of available methods and main results of crack propagation rate for both mechanisms in different steel grades.
- This TC will review theoretical and experimental results and it will propose a theoretical frame to calculate the durability and safety of structures undergoing SCC and HE.

Methodology

- Collection of documented results from the literature.
- Developing theoretical and conceptual reasoning within the committee.
- Exchange of experience and results, including unpublished ones, between TC members.
- Organization of workshops with invited presentations on selected topics to stimulate and focus the discussion.

Progress

- STAR in progress and planned to be complete within 3 years: table of content and contributors are set; currently drafting bibliography, test methods, analysis of previous results and models.

DCM: Long-term durability of structural concretes in marine exposure conditions

Chair: Kefei LI // Deputy chair: Junjie ZENG

Activity started in 2019

Significance

- Data collection from exposure stations is rather intuitive, and a systematic format for data collection/presentation is missing. The standardization of data presentation will greatly increase the added value of exposure data.
- The interpretation of exposure data through apparent chloride diffusivity is not enough, and the research community is ready to investigate more engineering indicators through more elaborated modelling.

Relevance

- The target users include the academics, the concrete and cement producers, and the owners of the exposure sites. Spin-off results can be formulated into educational courses for PhD students and professionals.
- TC would contribute both to the academic and industrial communities, to increase the usability of exposure data and promote the life cycle management of concrete infrastructures.

Exposure site in Hongkong-Zhuahai-Macau project site, China (2013).
Courtesy of HZMBA.

Exposure site in Cayo Santa-Maria, Cuba.
Courtesy of José Fernando Martirena Hernández.

Goals

- Gathering of long-term exposure data from in-field stations, with a detailed data-sharing policy set up within the group.
- Exploiting the long-term data using deepened models in collaboration with the exposure sites, with round robin tests for the simultaneous study for exposure-exposure and exposure-laboratory.
- General technical guideline for exposure stations.

Methodology

The TC work is divided into three phases:

- the establishment of a long-term exposure database for natural marine environments, and the correct presentation of exposure data;
- the exploitation of the long-term exposure data via mechanism interpretation, and the rational indicators for engineering use;
- the application of long-term exposure/observation data and their exploitation for the service life design and management of concrete infrastructures.

Progress

- TC starts in 2019, and the kick-off meeting will be organized in UCLV-2019 during the LEOSEO symposium (June 27th, 2019), Cayo Santa Maria, Cuba.

SHE: Self-healing concrete – Its efficiency and evaluation

Chair: Feng XING // Deputy chair: Erik SCHLANGEN

Activity started in 2016

Significance

- Concrete self-healing represents an affordable and efficient way to prevent structure deterioration triggered by the presence of cracks.
- There is a lack of a universal healing efficiency and evaluation methods for comparison, which is indispensable for the possible application in practice.
- Furthermore, these methods mainly can be used to assess healing of mechanical damage occurred in the material. Few methods are for deterioration of concrete due to reduction of pH value or ion intrusion.
- Various methods have been and are being developed in recent years. For the possible application in practice, it is essential to present accepted efficiency evaluation methods.

Picture of the 1st meeting of RILEM TC SHE.
Courtesy of Feng Xing.

Relevance

- Academics, postgraduate students, and researchers on concrete, and standardization committees, testing laboratories, concrete manufacture companies and government will be targeted by the outcomes of the TC.
- The self-resilience system for concrete (including self-healing and self-recovery) is regarded as an advanced and efficient way to deal with aging and durable structures from the environmental perspective.

Goals

- The intermediate goal is to obtain a number of methods for round-robin testing based on literature surveying.
- The final goal is to give a recommendation on a series of most suitable evaluation methods for self-healing and protection functionality recovery in concrete based on experimentation and numerical analysis.

Methodology

- The TC mainly focuses on efficiency and evaluation for self-healing concrete due to damage and for the concrete with protection functionality recovery.
- It will reach its scope through the work of three task groups (TG) that respectively focus on: 1) Literature review, 2) Efficiency and evaluation for self-healing concrete due to damage and 3) Efficiency and evaluation for the concrete with protection functionality recovery.

Progress

- Three meetings held so far (1st at Shenzhen University on 30 June 2016, 2nd at 6th ICSHM 2017, Friedrichshafen, Germany, and the 3rd at Delft on 28 Aug, 2018).
- Drafting of STAR: in progress.
- Round-robin test: to be carried out.

Cluster E:
Masonry, Timber and Cultural Heritage

Foreword from Cluster E Convener, **Enrico SASSONI**

Cluster E coordinates the activities of the Technical Committees (TCs) dealing with "Masonry, Timber and Cultural Heritage". At the moment, it comprises five TCs, working on timber (TC 245-RTE), rammed earth (TC 274-TCE), repair mortars (TC 277-LHS), masonry reinforcement (TC IMC) and decay induced by salt crystallization in various substrates (TC 271-ASC).

Several of these topics have been addressed by RILEM TCs since a long time, but only recently was a dedicated Cluster established.

In fact, the first recommendations on masonry date back to 1988, on timber to 1990, on rammed earth to 1997 and on historic mortars to 2000. RILEM TCs started working on these topics long ago, but the TC goals have progressively changed over time. As a general trend, the aim of the TCs has moved from the characterization of the historic substrates (e.g., mortar, masonry, timber) to the development of testing methods to assess the performance of conservation and reinforcement strategies for these substrates (e.g., repair mortars, composite materials applied to masonry and timber). To evaluate the suitability of the new conservation strategies, not only their effectiveness is addressed, but also their compatibility with the historic substrates, their durability over time and their environmental sustainability are gaining increasing attention by the TCs.

The recent decision to establish a Cluster specifically dedicated to the building materials constituting our Cultural Heritage has a twofold meaning to me. On the one hand, it is an important recognition of the value that RILEM attributes to research on these historic materials and to the urgency to develop successful strategies for their conservation. On the other hand, it highlights the importance that the research and the practice of cultural heritage conservation be carried out with the same rigorous scientific approach that RILEM applies to all the other fields of building materials and structures.

I have been Convener of Cluster E since September 2018, when I took over the role previously filled by Prof. Robert Flatt (ETH, Zurich). Prof. Flatt has dedicated much effort to promote communication between researchers and practitioners working in the field of cultural heritage conservation, to fill the gap that often exists between the two. Because the final goal of the RILEM TCs is that the scientific community can take advantage of their work and, at a larger scale, the society can benefit from scientific research and its transfer into practice, I strongly believe in such an approach and I will keep on pursuing it during my appointment as Cluster Convener.

245-RTE: Reinforcement of timber elements in existing structures

Chair: Jorge BRANCO // Deputy chair: Philipp DIETSCH

Activity started in 2011

Significance

- The need for structural reinforcement of timber buildings may become necessary because of changes of use and/or regulatory specifications, interventions to increase seismic resistance, deterioration due to poor maintenance, or exceptional damaging incidents.
- Structural reinforcement can be achieved by incorporating elements to increase strength and stiffness.
- The current available options like glued-in rods and self-tapping screws, to mention a few, are often not adapted for their use in-situ nor depending on whether the structure is part of the regular building stock or belongs to cultural heritage.

Relevance

- Increased knowledge of retrofitting techniques will help architects and engineers to make timber a viable option for more applications and new opportunities in design.
- Reliably reinforcing timber structures avoids failures and unnecessary decommissioning, and leads to safer structures and better use of resources.
- Using the genuinely renewable construction material timber and replacing non-renewable materials will increase economic incentives for sustainable forestry.

Courtesy of Jorge Manuel Branco.

Courtesy of Jorge Manuel Branco.

Goals

- To improve the reinforcement practice for timber structural elements.
- To disseminate up-to-date results to the industry, policy makers and society.
- To optimise collaboration of involved stakeholders in research and industry.

Methodology

- The scientific activities range from experimental to numerical and analytical approaches to study technologies for in-situ strengthening of wood structural members.
- Research is carried out on: timber and timber based products, composite systems, adhesive systems, mechanical fasteners, fibre reinforced polymers and natural fibres also applied in combination with adhesives, nanotechnology.
- The TC will focus on structural applications of timber in existing buildings of all ages and uses; other materials and non-structural timber applications are excluded.

Progress

- TC closure planned in December 2019.
- STAR currently being finalised.
- Final meeting scheduled in Guimarães, Portugal, in Sept 2019.

250-CSM: Composites for sustainable strengthening of masonry

Chair: Gianmarco DE FELICE // Deputy chair: Daniel OLIVEIRA

Activity started in 2012

Significance

- Composite materials are widely used to strengthen and repair masonry structures;
- Numerous innovative products have been developed and various materials have been proposed, including natural fibers such as flax and hemp;
- Exhaustive design instructions, assessment procedures to verify the effectiveness of the repair, monitoring programmes and inspection criteria still need to be fully defined;
- Currently available standard codes do not provide professionals with comprehensive instructions for the strengthening design;
- Both the compatibility with masonry support and the durability need to be ensured; accurate studies on this field are still lacking.

Relevance

- This TC integrates the standardization and recommendation groups, which have been or are still active in the field of the application of FRP and composite materials on structures (mainly concerning reinforced concrete), both at national and international levels;
- The outcomes of this TC will be beneficial to: testing laboratories, academics, industrial and professional people, contractors, managers of Cultural Heritage, service providers and general users of masonry structures and Cultural Heritage buildings;
- The innovative, efficient and aware repair/strengthening/retrofitting solutions proposed by this TC will allow the expected life of historic masonry constructions to be extended within economical and environmental efforts, ensuring their preservation and valorisation.

Testing setup for the round robin tests on mortar based composites.
Courtesy of Gianmarco de Felice.

Goals

- The work of the present TC aims at getting into the complex scenario of bringing together a quickly evolving industry of composite materials and their correct and safe applications;
- The proposed TC will also point out possible developments and in-depth studies on specific problems like fire resistance, material compatibility and reversibility, to mention a few;
- Relevant steps forward will be done, mainly focussing on the sustainability and compatibility of the materials when applied to architectural built heritage.

Methodology

- The work of the present TC is organized into five topics: Collection of existing data; Experimental and numerical activities; Development of techniques for the sustainable strengthening of the architectural heritage; Proposal of guidelines for testing and designing externally bonded mortar-based systems; Dissemination of results.

Progress

- De Felice et al. (2018), Recommendation of RILEM Technical Committee 250-CSM: Test method for Textile Reinforced Mortar to substrate bond characterization, *Materials and Structures*, 51:95.

271-ASC: Accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization

Chair: Barbara LUBELLI // Deputy chair: Inge RÖRIG-DALGAARD

Activity started in 2016

Significance

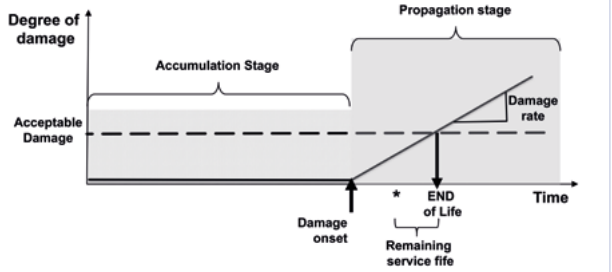
- Salt crystallization is a major cause of damage in porous building materials. Nowadays, in the practice of construction and conservation, the durability of materials with respect to salt crystallization is mostly determined by accelerated ageing tests.
- Existing (standard) crystallization tests are generally not realistically reproducing the transport and crystallisation process, resulting in unrealistic damage types.
- The need exists to overcome the above mentioned limitations by the development of an improved salt crystallization test procedure.

Relevance

- A reliable estimation of the durability of building materials with respect to salt crystallization is important for supporting decisions in the practice of construction and conservation (e.g. the selection of construction or restoration materials and/or the choice of replacing or not an existing material).
- All actors involved in decision making (e.g. architects, testing laboratories, advisors) will benefit by the development of an improved test.

Goals

- The main aim of the TC is to develop an effective (i.e. reliable and accelerated) salt crystallization test for the assessment of the durability of building materials to salt crystallization.
- The test procedure will be validated by a round robin test and by correlating the results from laboratory accelerated test with data from the field surveys.



Scheme of the approach for the to-be-developed accelerated test. Flatt R. et al. (2017).

Courtesy of Cristiana Nunes.

Methodology

- Critical review of accelerated crystallization test procedures, experimental research in laboratory for the development of the new test (including round robin test) and exchange of data collected by participants by on-site surveys and laboratory research.

Progress

- Lubelli B. et al. (2018) Towards a more effective and reliable salt crystallization test for porous building materials: state of the art, *Materials and Structures*, 51-55.
- Flatt R. et al. (2017) Predicting salt damage in practice: a theoretical insight into laboratory tests, *RILEM Technical Letters*, 2: 108-118.
- A draft test procedure is planned to be defined within the end of 2019 and round robin test planned for 2020.

274-TCE: Testing and characterisation of earth-based building materials and elements

Chair: Jean-Claude MOREL // Deputy chair: Antonin FABBRI

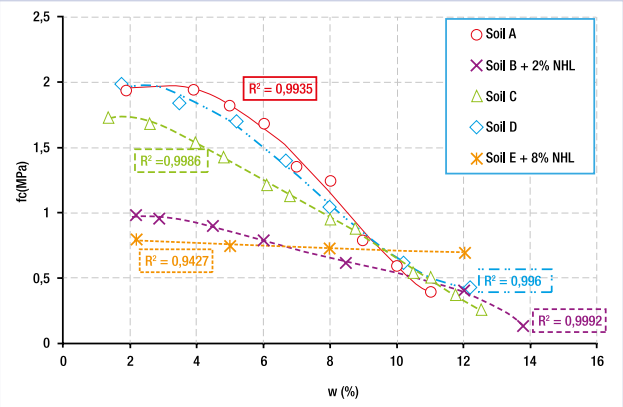
Activity started in 2016

Significance

- Earth used as construction material is characterised by significant complexities in behaviour and large variabilities in parameters.
- The ability of a soil to be used as a building material should be determined by its performances and not restrained to a specific composition.
- Experimentally obtained values of performance parameters are usually quite scattered.

Relevance

- Earth-based building materials, an environmentally-friendly technique, can help to reduce carbon footprint.
- Producing guidelines for engineers, architects and practitioners that are currently not available will promote the use of this technique.



Courtesy of TC 274-TCE.

Courtesy of Jean-Claude Morel.

Goals

- To define dedicated testing procedures for unstabilised earth in the form of rammed earth, cob, earth blocks, etc.
- To encourage the transfer of TC's findings to practitioners through the publication of guidelines and the organisation of dedicated workshop.

Methodology

- To define the minimal number of laboratory tests needed to provide an accurate assessment of the mechanical, thermal and hygroscopic performances of the material through existing and newly developed experimental tests.
- To validate the accuracy of the tests by comparing laboratory and on-site data. The used earth samples will come from existing construction sites that will be properly instrumented.

Progress

- Fabbri A. et al. (2018) Assessing the performance of earth building materials: a review of recent developments, *RILEM Technical Letters*, 3: 46-58.

277-LHS: Specifications for testing and evaluation of lime-based repair materials for historic structures

Chair: Ioanna PAPAYIANNI // Deputy chair: Jan VALEK

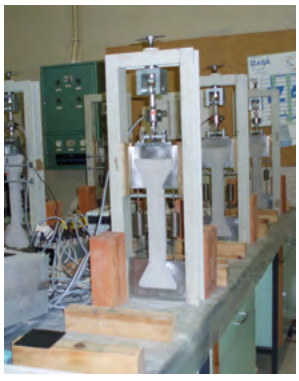
Activity started in 2017

Significance

- The current trend in repairing Historic Structures (HS) is the use of lime-based materials L-b-M. However, test procedures for repair mortars/grouts follow standards established for cement-based mortars/grouts.
- It is important to adapt/modify standard procedures for testing basic properties of L-b-M to define a harmonized scientific basis and pre-normative frame for them.
- Adaptation of field test methods verified by laboratory tests.

Relevance

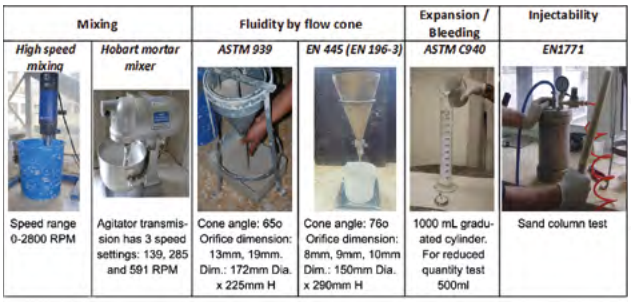
- Industry is advantaged from upgrading the quality, reliability and performance of prefab materials for HS.
- The market L-b-M is facilitated all over Europe.
- Construction industry is benefited from the quality of the repair works.
- Any investment in HS preservation gains extra value.



Review of restrained shrinkage tests.
Veiga R. et al. RILEM SMSS Convention 2019.

Goals

- State of the Art reports about currently used test procedures in fresh and hardened state for L-b-M.
- Harmonized and unified test procedures for L-b-M.
- Design repair of HS based on more realistic data in terms of properties, behaviour and performance of L-b-M by adapting specific to L-b-M test methods of their quality.



Mixing and testing equipment for round robin tests for grouts.
Courtesy of Ioanna Papayianni.

Methodology

- Preparation of two documents on: Mechanisms of Setting and Hardening of L-b-M and Admixtures, Additives and Additions in L-b-M as basis for the works of TC.
- Selection of all standards (EN, ISO, ASTM, etc.) pertinent to testing quality of L-b-M.
- Review of suitability of existing test methods in evaluating the performance of L-b-M.
- Propose adaptations/modifications to standard methods and field tests.

Progress

- Papayianni I. and Hughes J. (2018) Testing properties governing the durability of Lime-based Repair Mortars, *RILEM Technical Letters*, 3:135-139.
- Groot C. et al. (2019) Durability aspects related to repointing of historic mortars with lime based mortar, RILEM SMSS Convention, Rovinj, Croatia, 18-21 March 2019.
- Pachta V. et al. (2019) Evaluation of the fresh state properties of lime-based grouts through inter-laboratory comparative testing, 5th Historic Mortars Conference (HMC 2019), Pamplona, Spain, 19-21 June 2019.

IMC: Durability of inorganic matrix composites used for strengthening of masonry constructions

Chair: Maria Antonietta AIELLO // Deputy chair: Catherine PAPANICOLAOU

Activity started in 2019

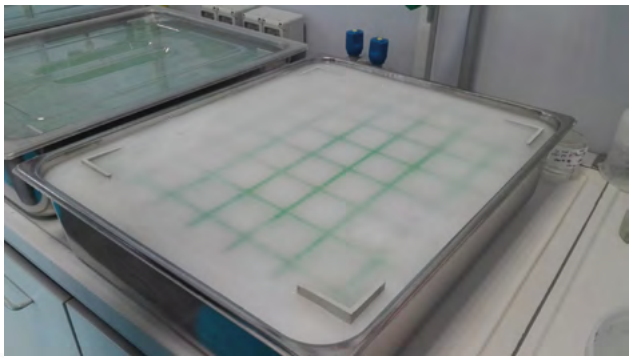
Significance

- Fiber Reinforced Polymer (FRP) materials do not always provide an efficient strengthening solution for masonry structures. Inorganic Matrix Composites (IMC) have been studied as an affordable solution, especially for historical masonry.
- At the moment, durability is the major gap within the scientific knowledge. The study of the long-term behaviour is necessary in order to provide complete design guidelines for practitioners.

Tensile tests of FRCM.
Courtesy of Maria Antonietta Aiello.

Relevance

- The beneficiaries of the research will be manufacturers who provide FRCM systems and practitioners who are asked to certify design by using FRCM.
- Public and private institutions involved in the formulation of design codes will be supported by the advancement of the knowledge brought by the results of the IMC-TC.
- Safety coefficients taking into account the long-term issues, may be provided.



Ageing of fibrous reinforcements.
Courtesy of Maria Antonietta Aiello.

Goals

- To narrow the gap in knowledge that may limit the use of FRCM materials in structural strengthening of masonry buildings.
- Testing ageing procedures in laboratory environment, able to define shared certification protocols.
- Provide useful information for the formulation of design equations to be introduced in technical codes and guidelines.

Methodology

- Systemization of the existing (limited) knowledge on the matter.
- Drafting and realization of accelerated ageing protocols under different exposure agents on components (textiles, matrices), composites and assemblages.
- Assessment of post-ageing residual mechanical properties (e.g. through tensile and single lap/single prism shear bond tests); comparison with counterpart unexposed specimens.
- Analytical study to formulate relationships between the detrimental effects of temperature-accelerated tests and ageing protocols performed at 23°C.

Progress

- Kick-off meeting in Bologna, during the MuRiCo6 conference, in June 2019.

RILEM
TECHNICAL REPORT

Cluster F: Bituminous Materials and Polymers

Foreword from Cluster F Convener, **Michael WISTUBA**

Since the late 1960s RILEM activities in the field of Bituminous Materials and Polymers have been focusing on design and technical development of bituminous pavement infrastructures, that are mainly built from natural aggregate and asphalt binders derived from crude oils. Facing the global shortage of these materials, a number of around 20 Technical Committees have been treating the challenging objectives to characterize and steadily develop the complex performance of these materials as well as to optimize design, construction, rehabilitation and recycling technologies to achieve most sustainable life cycles.

Currently, the Cluster F, chaired by Michael P. Wistuba, TU Braunschweig (DE), assisted by experts Hervé Di Benedetto, U Lyon (FR), and Eshan V. Dave, U New Hampshire (US), engages approximately 150 experts from 25 countries, and is composed of 5 Technical Committees.

These committees are and have always been most efficient research and development platforms for connecting professionals from all over the world in the field of bituminous materials research to share their expertise, to develop recommendations on testing and evaluation approaches and to publish state-of-the-art reports and papers in the RILEM Journals of Materials and Structures as well as in other journals and conference proceedings. Activities under the umbrella of RILEM have contributed a lot to strengthen the asphalt research community, and to steadily remind all members of being united people, researching together for a prosperous and sustainable future.

A number of approximately 20 individual TC meetings, symposia, and seminars, took place since the late 1960s, i. e. in Dresden (1968), Budapest (1975, 1990), Darmstadt (1978), Belgrade (1983), Olivet (1986), Dubrovnik (1988), Liège (1989, 1993), Maastricht (1996), Lyon (1997), Ottawa (2000), Zurich (2003), Limoges (2004), Chicago (2008), Rhodes (2009), Delft (2012), Stockholm (2013), Ancona (2015), Nantes (2016), and Braunschweig (2018).

Moreover, some well attended and broadcasted annual joint meetings, e. g. in Nottingham (2017), Braunschweig (2018), and Waterloo (2019), requested the establishment of a regular joint conference, for promoting latest developments in this research field also to a wider audience. For this purpose, the first Cluster F International Symposium on Bituminous Materials (ISBM), will take place 2020, June 8th to 10th in Lyon (FR), also presenting results from the above mentioned TCs 264-RAP, 272-PIM and 278-CHA.

The Cluster F community was very delighted to congratulate its members Fernando Moreno-Navarro, U Granada (ES), and Augusto Cannone Falchetto, TU Braunschweig (DE), for being nominated Robert L'Hermite Medallist 2018, and 2019, respectively, the most prestigious RILEM award.

264-RAP: Asphalt pavement recycling

Chair: Gabriele TEBALDI // Deputy chair: Eshan V. DAVE

Activity started in 2015

Significance

- Recycling of asphalt materials for highway construction has become a necessity due to the declining sources for new aggregates, increased costs and environmental impacts of using asphalt.
- The current mix design methods to include recycled asphalt (RA) are basically adjustments of the mix design methods developed for traditional asphalt mixtures.
- It is necessary to understand the role of RA in new mixes and its interaction with other constituents is urgently needed.
- The need exists for exploring the life-cycle analysis (LCA) tools that provide comprehensive evaluation of the economical, energy and environmental impacts of RA usage.

Courtesy of Eshan Dave.

Relevance

- Academics, road authorities and standardization committees, testing laboratories and test equipment producers, material producers and construction equipment manufacturers and researchers will benefit from the work of this TC.
- This TC will provide practitioners with an optimization tool to help maximize the use of RA materials without affecting the performance of infrastructure system.
- The LCA results can provide support to agencies in decision-making processes.

Goals

- Fundamental understanding on the issues related to characteristics of RA mixtures.
- Bringing cutting-edge research solutions from academia to the practitioners (road transportation administration and pavement industry).
- Development of standards and work protocols to be adopted by practitioners.
- Delivering methods and manuals to state and national transportation agencies.
- Delivering "Research Needs Statement" documents to address the research activities and to underline the knowledge gaps for researchers and road administrations.

Methodology

- Investigations are conducted at the laboratory evaluation and field assessment scales.
- Interaction with industries and road administration in different countries/continents.
- This TC is organized in the form of five task groups: TG1 Cold Recycling - with foamed bitumen and with bituminous emulsion; TG2 Hot and Warm Recycling; TG3 Asphalt Binders and Additives for RA; TG4 Life Cycle Assessment; TG5 Degree of Binder Activation.

Progress

- Organization of three industry workshops (Zurich 2017, São Paulo 2018 and Granada 2019) and a series of educational webinars;
- Survey of researchers and practitioners on Pavement LCA methods in context of asphalt recycling;
- 1st research need statement published (> 2000 views/downloads); more underway;
- Four inter-laboratory studies with over 30 participating laboratories is currently underway.

272-PIM: Phase and interphase behaviour of bituminous materials

Chair: Emmanuel CHAILLEUX // Deputy chair: Christiane RAAB

Activity started in 2016

Significance

- Innovation in the field of pavement construction is always facing difficulties in defining the "relevant" properties not only for the innovative products, but also in comparison with conventional solutions.
- To facilitate sustainable implementations of new materials, additives and processes, it is necessary to:
  - o Go towards intrinsic evaluation, relevant to the actual field performance;
  - o Conduct studies at different scales: binder, mastics, mixture and pavement such as single layered structures;
  - o Understand bituminous materials as multiphase materials.

Courtesy of Emmanuel Chailleux.

Relevance

- Environmentally friendly, long term resistant and better performing roads are of great economic importance. Hence, the economic impact of the proposed work will be high.
- Results will be used as basis to improve national and international standards as well as the exchange of data and experience.
- Results and findings will be used as basis to establish worldwide consensus and further coordinate development in this field.
- They will also be a good basis for education of young researchers and engineers.

Goals

- This TC aims to provide recommendations, in term of experimental tools, for the asphalt research and engineering community, concerning performance assessment of innovative bituminous materials.

Methodology

- The first period (one or two years) was dedicated mainly to experimental methods. During this period each Task Group (TG1: Binders, TG2: Mixtures, TG3: Pavement multilayer system) works independently.
- In a second phase, common innovative materials linked to actual sustainability issues will be chosen and shared across TGs in order to have, finally, a complete evaluation of the innovative solutions.

Progress

- TG1: Round-robin test started in spring 2019 with 10 participating laboratories.
- TG2: Round-robin test started in 2018 with 11 participating laboratories. Majority of results of first series already available.
- TG3: Round-robin test started in 2018 with 9 participating laboratories.

278-CHA: Crack healing and asphalt pavement materials

Chair: Hassan BAAJ // Deputy chair: Orazio BAGLIERI

Activity started in 2016

Significance

- Cracking is one of the most prevalent deterioration modes of asphalt pavements and it is caused by traffic loading and environmental actions.
- Service life of asphalt mixtures can be significantly increased by means of technical solutions focused on the prevention and healing of asphalt cracks.
- The pavement industry has explored Self-Healing Materials (SHM) to help create asphalt mixes that can close their own cracks or even prevent cracks before they happen.
- No standard test methods are currently available for the evaluation of healing potential of asphalt materials.

Courtesy of Hassan Baaj.

Relevance

- The TC will deal with healing phenomena of asphalt binders and mixtures and will contribute to increase knowledge in an area of great interest for the scientific community.
- The improved service life of asphalt pavement through the use of materials with high healing capability will contribute to reduce the cost of road construction and maintenance.
- The outcomes will educate a new generation of highly technically qualified engineers who are sensitive to sustainable development and environmental issues. These will contribute to lead the change towards more sustainable civil engineering infrastructures through their work in academia, construction and building materials industries, engineering firms and governmental transportation authorities.

Goals

- The TC will explore the use of test methods and techniques for the induction of cracking in asphalt materials and for quantification of their healing potential.
- The work of the TC should lead to the development of technical criteria for the selection of materials with improved healing properties thus contributing to the improvement of durability of pavement structures with less maintenance.

Methodology

- The principal tasks of this TC will be shared amongst 3 Task Groups: 1) literature review; 2) laboratory experimentation and 3) numerical modelling.
- The literature review will focus on i) cracking in asphalt pavements and tests to induce and evaluate it and ii) self-healing methods for asphalt pavement.
- The laboratory experimentation will investigate procedures for evaluating self-healing properties of asphalt binders and mixtures.
- The numerical modelling will develop a numerical prediction of asphalt pavement cracking and healing of asphalt pavement.

Progress

- Final STAR will be published at the end of TC life.

279-WMR: Testing of waste and marginal materials for road pavements

Chair: Lily D. POULIKAKOS // Deputy chair: Bernhard HOFKO

Activity started in 2017

Significance

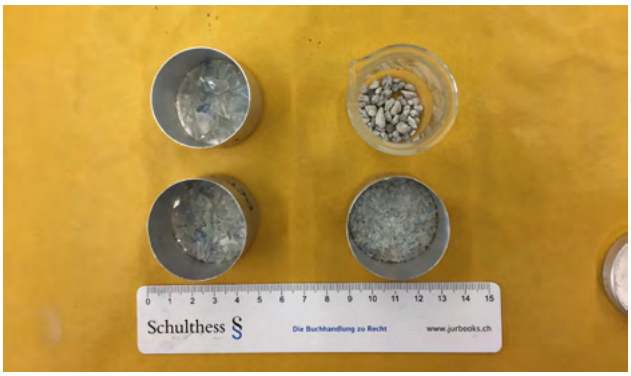
- Use of various waste materials in roads is a technically viable option without decreasing durability.
- In comparison to mixtures made of all virgin components life cycle assessment and cost analysis (LCA, LCC) have demonstrated significant savings in costs, CO2 and energy.

Relevance

- The technical readiness level (TRL) among the investigated materials varies greatly.
- The primary barrier for use of waste materials is knowledge and therefore the scientific community needs to make a more significant effort to bring the acquired knowledge to the practicing professionals.
- Appropriate legislation and standards need to guide road authorities and contractors on the use of waste for road construction.

Goals

- Identifying waste materials that are performance enhancing components for road materials.
- Investigating suitable binder additives, performance of the modified binders, suitable aggregate substitutes and performance in mixtures.
- Investigating possible polluting consequences.
- Using LCA/LCC to show that these materials are environmentally and economically desirable
- Recommending suitable waste materials and limit amounts for use in roads.



Courtesy of Lily Poulikakos.

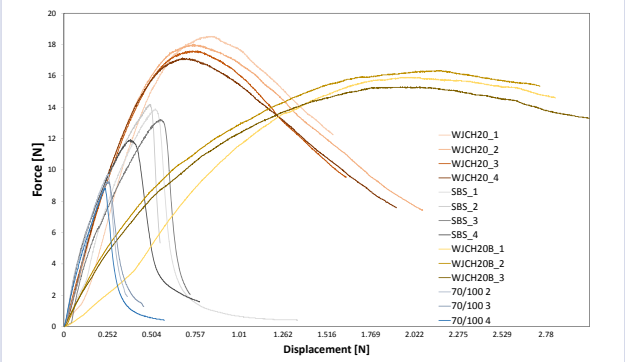
Methodology

Five technical groups (TG) have been formed:

- TG1 investigates the use of binder additives such as plastics.
- TG2 focuses on replacing conventional aggregates with recycled waste materials such as C&D waste and steel slags.
- TG3 characterizes combined use of different recycled waste materials.
- TG4 focuses on environmental assessment; potential sources of pollutants.
- TG5 will perform Life cycle assessment.

Progress

Since its inception the TC has defined five technical groups (TG) and TG leaders. The work program including material's selection and round robin tests have been defined. The materials have been delivered to the participating laboratories.



◀ *Rubber modified asphalt displays higher fracture energy.* Loderer et al. (2018).

280-CBE: Multiphase characterisation of cold bitumen emulsion materials

Chair: Andrea GRAZIANI // Deputy chair: Alan CARTER

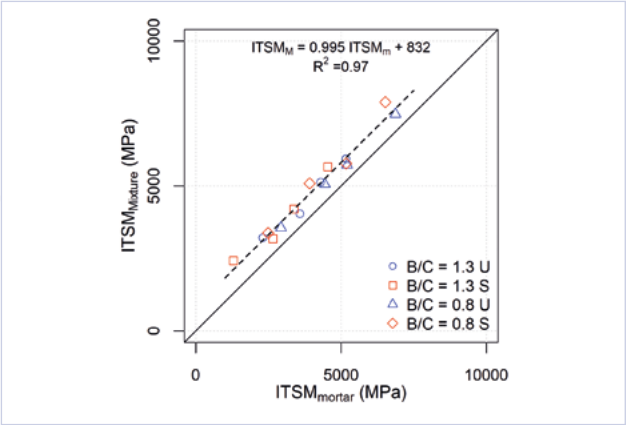
Activity started in 2017

Significance

- Cold bitumen emulsion technologies are proven sustainable solutions for pavement construction and rehabilitation
- A lack in fundamental knowledge on the long-term behaviour of structural and non-structural cold bitumen emulsion materials limits their usage.

Relevance

- A better understanding of the properties of those materials will lead to significant energy savings and will help to reduce greenhouse gas emission compared to actual standard pavement construction techniques;
- The results of this TC will be useful to researchers, engineers, owners of infrastructures and practitioners in the field of pavement materials.



Courtesy of Andrea Graziani.

Goals

- To collect, summarize and improve the fundamental knowledge related to chemical and physical mechanisms that control the mechanical behaviour and the performance of CBE materials;
- To evaluate testing methodologies for the physical and mechanical characterization of CBE materials and suggest worldwide harmonisation of existing standards.

Courtesy of Andrea Graziani.

Methodology

- The committee will collect and analyse relevant publications and expert opinions related to cold emulsion bitumen technologies in order to prepare state-of-the-art reports
- Two TG will make interlaboratory exchange program to better define the time-dependent behaviour of those materials
- Preparing joint publications on the state-of-the-art in the field

Progress

- Interlaboratory tests on Slurry Surfacings (2018) and Bitumen Emulsion Mortars (2019) have been initiated.
- RILEM SMSS Conference – Special RILEM TC sessions: Cold bitumen emulsion materials, 10 papers presented, RILEM SMSS Conference, Rovinj, Croatia, March 20, 2019
- Grilli A. et al. (Submitted March 2019) Slurry surfacing: a review of definitions, descriptions and current practice, *RILEM Technical Letters*.

Upcoming RILEM publications

I. CONFERENCE AND WORKSHOP PROCEEDINGS

1) Proceedings to be published by Springer

External Sulphate Attack – Field Aspects and Lab Tests - RILEM Final Workshop of TC 251-SRT, 24-25 May 2018, Madrid, Spain.

Proceedings of the International Conference of Sustainable Production and Use of Cement and Concrete - ICSPCC 2019, 23-30 June 2019, Cayo Santa Maria, Cuba.

Rheology and Processing of Construction Materials - RheoCon2 & SCC9, 9-11 September 2019, Dresden, Germany.

Proceedings of the 3rd International Conference on Calcined Clays for Sustainable Concrete, 15-17 October 2019, New Delhi, India.

Proceedings of SAP 2019 - Third International RILEM Conference on the Application of Superabsorbent Polymers and Other New Admixtures Towards Smart Concrete, 25–27 November 2019, Kruger National Park, South Africa.

2) Proceedings to be published by RILEM Publications SARL

PRO 123: Final Conference of RILEM TC 253-MCI: Microorganisms-Cementitious Materials Interactions, 25-26 June 2018, Toulouse, France.

PRO 130: 5th Historic Mortars Conference, 19-21 June 2019, Pamplona, Spain.

PRO 131: (online version): 3rd International Conference on Bio-Based Building Materials (ICBBM2019), 26-28 June 2019, Belfast, United Kingdom.

PRO 132: IRWRMC'18 - International RILEM Workshop on Rheological Measurements of Cement-based Materials, 30-31 May 2018, Arras, France.

II. State-of-the-Art (STAR) AND TC DOCUMENTS

1) STARs

TC 245-RTE: Reinforcement of existing timber elements and structures - State-of-the-art report of the RILEM Technical Committee 245-RTE.
Edited by Jorge Branco, Philipp Dietsch, Thomas Tannert.

TC 249-ISC: Non-destructive in situ strength assessment of concrete - State-of-the-art report of the RILEM Technical Committee 249-ISC.
Edited by Denys Breysse, Jean-Paul Balayssac.

TC 259-ISR: Diagnosis and Prognosis of Alkali Aggregate Reactions Affected Structures - State-of-the-art report of the RILEM Technical Committee 259-ISR.
Edited by Victor Saouma.

Upcoming RILEM publications

2) New RILEM Recommendations

Recommendation of RILEM TC 237-SIB: Fragmentation Test for Recycled Asphalt.
Chair: Manfred PARTL
Deputy Chair: Emmanuel CHAILLEUX

Recommendation of RILEM TC 249-ISC on Non Destructive In-situ Strength Assessment of Concrete.
Chair: Denys BREYSSE
Deputy Chair: Jean-Paul BALAYSSAC

Recommendation of RILEM TC 252-CMB: Relationship between Laboratory Short-Term Aging and Performance of Asphalt Binder.
Chair: Nicole KRINGOS
Deputy Chair: Lily POULIKAKOS

Recommendation of RILEM TC 260-RSC for using superabsorbent polymers (SAP) for improving freeze-thaw resistance of cement-based building materials.
Chair: Viktor MECHTECHERINE
Deputy Chair: Mateusz WYRZYKOWSKI

3) Other TC documents published in Materials and Structures

TC 247-DTA: Provis et al., RILEM TC 247-DTA Round Robin Test: Mix design and reproducibility of compressive strength of alkali-activated concretes.

TC 252-CMB: Falchetto et al., RILEM TC 252-CMB Report: Rheological Modeling of Asphalt Binder under Different Short and Long-term Aging Temperatures.

TC 262-SCI: Angst U. et al., The effect of the steel-concrete interface on chloride-induced corrosion initiation in concrete.

WWW of upcoming RILEM events – WHERE, WHAT AND WHEN

RILEM TECHNICAL REPORT

The following events are those that have been registered up to May 2019. For the updated list, please consult the RILEM webpage as RILEM events are constantly being added.

WHEN: Thursday 5th September to Saturday 7th September 2019
WHAT: RILEM International Conference Strategies for Sustainable Concrete Structures – SSCS 2019
WHERE: Lecco, Italy

WHEN: Sunday 8th September to Wednesday 11th September 2019
WHAT: 9th International RILEM Symposium on Self Compacting Concrete (SCC9) & 2nd International RILEM Conference on Rheology and Processing of Construction Materials (RheoCon2)
WHERE: Dresden, Germany

WHEN: Monday 9th September to Tuesday 10th September 2019
WHAT: 39th Cement and Concrete Science Conference
WHERE: Bath, United Kingdom

WHEN: Tuesday 10th September to Wednesday 11th September 2019
WHAT: Durable Concrete for Infrastructure under Severe Conditions
WHERE: Ghent, Belgium

WHEN: Thursday 19th September to Friday 20th September 2019
WHAT: 6th International Workshop on Concrete Spalling due to Fire Exposure
WHERE: Sheffield, United Kingdom

WHEN: Wednesday 25th September to Friday 27th September 2019
WHAT: SHATiS'19 - International Conference on Structural Health Assessment of Timber Structures
WHERE: Guimarães, Portugal

WHEN: Thursday 26th September to Saturday 28th September 2019
WHAT: International fib Symposium on Conceptual Design of Structures
WHERE: Madrid, Spain

WHEN: Monday 30th September to Wednesday 2nd October 2019
WHAT: Concrete Solutions - 7th International Conference on Concrete Repair
WHERE: Cluj Napoca, Romania

WHEN: Tuesday 15th October to Thursday 17th October 2019
WHAT: 3rd International Conference on Calcined Clays for Sustainable Concrete
WHERE: New Delhi, India

WHEN: Monday 21st October to Friday 25th October 2019
WHAT: Corrosion Science & Corrosion Control for Infrastructure
WHERE: Delft, The Netherlands

WHEN: Monday 25th November to Wednesday 27th November 2019
WHAT: SAP 2019 - Third International RILEM Conference on the Application of superabsorbent Polymers and Other New Admixtures Towards Smart Concrete
WHERE: Kruger National Park, South Africa

WHEN: Tuesday 10th December to Thursday 12th December 2019
WHAT: 1st International Conference on Smart Materials for Sustainable Construction
WHERE: Luleå, Sweden

WWW of upcoming RILEM events – WHERE, WHAT AND WHEN

WHEN: Tuesday 14th January Thursday 16th January 2020
WHAT: 3rd International RILEM Workshop on Concrete Durability and Service Life Planning
WHERE: Haifa, Israel

WHEN: Tuesday 10th March to Saturday 14th March 2020
WHAT: RILEM Spring Convention and Workshop on Ambitioning a Sustainable Future for Built Environment: comprehensive strategies for unprecedented challenges
WHERE: Guimarães, Portugal

WHEN: Thursday 7th May to Friday 8th May 2020
WHAT: International Conference on "Cement-based Materials tailored for a Sustainable Future" in honour of Prof. Surendra P. Shah and Prof. Turan Özturan
WHERE: Istanbul, Turkey

WHEN: Tuesday 26th May to Thursday 28th May 2020
WHAT: 4th International RILEM Conference on Microstructure Related Durability of Cementitious Composites
WHERE: The Hague, The Netherlands

WHEN: Monday 8th June to Wednesday 10th June 2020
WHAT: RILEM International Symposium on Bituminous Materials (ISBM Lyon 2020)
WHERE: Lyon, France

WHEN: Monday 29th June to Wednesday 1st July 2020
WHAT: 11th ACI/RILEM International Conference on Cementitious Materials and Alternative Binders for Sustainable Concrete
WHERE: Toulouse, France

WHEN: Tuesday 30th June to Friday 3rd July 2020
WHAT: 15th International Conference on Durability of Building Materials and Components 2020
WHERE: Barcelona, Spain

WHEN: Wednesday 1st July to Friday 3rd July 2020
WHAT: 9th International Conference on Maintenance and Rehabilitation of Pavements
WHERE: Zurich, Switzerland

WHEN: Monday 6th July to Wednesday 8th July 2020
WHAT: Digital Concrete 2020 - 2nd RILEM International Conference on Concrete and Digital Fabrication
WHERE: Eindhoven, The Netherlands

WHEN: Wednesday 26th August to Friday 28th August 2020
WHAT: 13th fib International PhD-Symposium In Civil Engineering
WHERE: Marne-la-Vallée, France

WHEN: Sunday 30th August to Friday 4th September 2020
WHAT: 74th RILEM Annual Week
WHERE: Sheffield, UK

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Concluding remarks from the RILEM Presidency

RILEM is doing exactly what Gustavo Colonnetti wanted – these are the words of Madame Margherita Colonnetti, the daughter of Prof. Colonnetti, the 1st RILEM President and the organizer of a conference in Turin in 1947 to discuss international collaboration on materials and structures for reconstruction after the war. Her presence was one of the highlights of the RILEM Convention in Rovinj, Croatia, during March 2019. She spoke about Colonnetti's call for the responsibility of researchers especially in the area of construction, toward mentoring young people and playing a role in the betterment of society in general. A video was recorded giving her thoughts on this occasion that can be accessed on YouTube.

The 2019 RILEM Convention sparkled with the great success of the Sustainable Materials, Systems and Structures Conference, organized very ably and warmly by Profs. Dubravka Bjegović, Marijana Serdar, Nina Štirmer and their teams. The conference proceedings can be downloaded from the RILEM website.

As we take immense pleasure and satisfaction in writing these concluding remarks of the first RILEM Technical Report, to which we have endeavoured to give a flavour different from the more formal RILEM Annual Report, we are proud of the work being done by our Technical Committees, the heartbeat of RILEM. This report is meant to be a celebration of the efforts of experienced researchers and industry practitioners, all TC members who make RILEM a vibrant organization! They consolidate their knowledge and dedicate time towards the development and dissemination of safe and up-to-date construction practices and sustainable technologies, for the betterment of society as Colonnetti envisioned.

As we look forward, we draw inspiration from the giants whose shoulders we stand on, for example when we refer to the RILEM 30-year Anniversary report.

What has changed in the last 42 years of life of the RILEM Technical Committees and where do we go from here?

Recommendations and Standards: In 1977, each technical committee committed to prepare recommendations that, after approval of ISO, could be accepted as international standards. Nowadays, many recommendations produced by the TCs have been adopted in research and practice, and are often used by international standardisation bodies as a basis for their work. The TAC has recently embarked on a massive exercise to assess all the recommendations for their validity and to examine the need for updation.

Topics: There has been continuity in the work of our TCs, with topics researched on during the first 30 years of RILEM being still continued in some form or other. Some examples of the continuity are given below linking the early TCs to current ones:

- 3-TT: Testing methods of timber → 245-RTE: Reinforcement of timber elements in existing structures
- 12-CRC: Corrosion of reinforcement in concrete → 262-SCI: Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion
- 16-C: Carbonation → 281-CCC: Carbonation of concrete with supplementary cementitious materials
- 17-BM: Bitumen and bituminous materials → 272-PIM: Phase and Interphase behaviour of bituminous Materials
- 29-PSP: Pore structures and properties of materials → GDP: Test methods for gas diffusion in porous media
- 32-RCS: Resistance of concrete to chemical attacks →TMS: Test method for concrete durability under combined role of sulphate and chloride ions and 252-SRT Sulfate resistance testing
- 37-DRC: Destruction and re-use of concrete → 273-RAC: Structural behaviour and innovation of recycled aggregate concrete
- 43-CND: Combined non-destructive testing methods → 249-ISC: Non-destructive in situ strength assessment of concrete.

Concluding remarks from the RILEM Presidency

Response to advances in technology: Though there has been continuity in some topics, RILEM has been at the forefront of new technologies as reflected, for example, by the current *TC 276-DFC Digital fabrication with cement-based materials, TC 260-RSC Recommendations for use of superabsorbent polymers in concrete construction* and *TC 280-CBE Multiphase characterisation of cold bitumen emulsion materials*.

Responsibility toward the environment: The emphasis on sustainability of products and technologies has grown and many TCs tackle environmental issues that our planet faces, like for instance *TC 263-EEC Environmental evaluation of concrete structures toward sustainable construction* and *TC 279-WMR Valorisation of Waste and Secondary Materials for Roads*.

Camaraderie and joviality: The atmosphere at the RILEM events and meetings has definitively not changed since the beginning of the organization. The friendships established and the good times have endured and flourished, as can be seen in the photographs below.

▲ *Pleasant moments between the sessions of the meeting in Zurich in 1962 on "The relative slow development of building industry research in comparison with other industries.* Courtesy of RILEM.

▲ *Jovial moments at the 2016 RILEM Dinner.* Courtesy of Hiroyuki Miyauchi.

As we celebrate the work of the members of the various technical and standing committees of RILEM, we also thank the staff in the General Secretariat in Paris who play a silent yet significant role in all our success stories. We have strengthened our team with the incorporation of Dr. Daniela Ciancio as the Implementation Manager and Ms. Judith Hardy as the incoming Secretary General, who join the ever reliable and dedicated Ms. Pascale Ducornet, the Secretary General, and the cheerful and tech savvy Ms. Anne Griffoin, the coordinator of reporting, web site and more. This 2018-2019 Technical Report, the first of many more to come, has been made possible within a challenging timeline by Daniela, who piloted the venture with confidence and cheerfulness, along with Anne who made sure of the aesthetics and print quality.

We welcome suggestions on how we can make the Technical Report more useful to our members and others who could benefit from its dissemination. We will include more information, especially on educational activities and outreach to young researchers, in future editions.

Ravindra, Nicolas and Johan

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2nd RILEM Spring Convention, Rovinj, Croatia. Courtesy of Ivan Balaband.

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