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

2019
2020

Technical Report

rilem

About RILEM

The International Union of Laboratories and Experts in Construction Materials, Systems and Structures (RILEM, from the name in French – Réunion Internationale des Laboratoires et Experts des Matériaux, systèmes de construction et ouvrages) was founded in June 1947 in Paris, France, with the aim of promoting scientific cooperation and to stimulate new directions for research and applications, thus promoting excellence in construction worldwide.
This mission is achieved through the collaboration of leading experts in construction science and practice, including academics, researchers, industrialists, testing laboratories, and authorities.

Become a member

If you are interested in joining RILEM, please consult our website **www.rilem.net** and become a member.

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
- 20% discount on all Springer / Nature e-books
- Opportunity to publish selected articles as free OA paper in *Materials & Structures* and in *RILEM Technical Letters*

Individual fees in 2020

Student Member	€ 25	Affiliate Member	€ 100
Senior Member	€ 375	Retired Member	€ 75

Corporate fees in 2020

Institutional Member	€ 2 205	Industrial Member	€ 4 050
Associate Member	€ 1 165		

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Editorial

by RILEM TAC Chair Nele De Belie

I find myself writing this Editorial for the second issue of the RILEM Technical Report in probably one of the most challenging periods for the humankind: I am obviously referring to the COVID-19 epidemic, affecting people everywhere in the world. As RILEM members and targeted readers of this report are from all around the globe, it is almost mandatory to mention this situation.

The corona virus started to have an impact on our Chinese colleagues by the end of last year. It has quickly and in certain cases quite unexpectedly found its way to the rest of the world in March this year.

Ironically enough, the 73rd RILEM Annual Week was held in Nanjing, China, in August 2019, when the corona virus epidemic had not started yet. It was a fabulous event that gathered more than 280 delegates. At the RILEM Technical Activities Committee (TAC) meeting, the following changes were proposed and approved:

1) Daman Panesar to replace Barzin Mobasher as Convener of Cluster A.
2) Pietro Lura and Daman Panesar to be replaced as TAC experts by Anya Vollpracht and Daniel Oliveira.
3) The 2020 jury of the Robert L'Hermite and Gustavo Colonnetti medals to be formed by: Daman Panesar, Arun Menon, Alexandra Bertron and Nele De Belie.

As chair of TAC, I also announced the closure of the following TCs:

- 251-SRT, Sulfate resistance testing, chaired by Véronique Baroghel-Bouny
- 253-MCI, Microorganisms-cementitious materials interactions, chaired by Alexandra Bertron
- 255-FRS, Fire resistance of concrete structures repaired with polymer cement mortar, chaired by Takafumi Noguchi
- 259-ISR, Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reactions, chaired by Victor Saouma
- 263- EEC, Environmental evaluation of concrete structures toward sustainable construction, chaired by Amnon Katz
- 245-RTE, Reinforcement of Timber Elements in Existing Structures, chaired by Jorge Branco

In addition, we were happy to approve several new ones:

- CCS, Early age and long-term crack width analysis in RC Structures, chaired by Miguel Azenha
- MPA, Mechanical properties of alkali-activated concrete, chaired by Guang Ye
- MCC, Mechanical Characterization and Structural design of Textile Reinforced Concrete, chaired by Barzin Mobasher.

In Nanjing, those TCs that had recently terminated their activities or were nearly closing, shared their work with the conference delegates during a plenary session: Takafumi Noguchi (TC 255-FRS) discussed the fire resistance of concrete repaired with polymer cement mortar, Alexandra Bertron (TC 253-MCI) presented the interactions between microorganisms-cementitious materials, Karen Scrivener (TC 267-TRM) talked about the reactivity of supplementary cementitious materials and its testing procedures and Lily Poulikakos (TC 252-CMB) deliberated about the chemo-mechanical characterization of bituminous materials.

The increased impact of the virus in Europe around March created very challenging conditions for the organisation of the 3rd RILEM Spring Convention in Guimarães, Portugal. As you can read in more details in the report of this event on page 1, the event organisers had only a few hours to turn the conference into a mix of an on-site and virtual event, and they managed to do it in a very successful way!

TAC members that travelled to Guimarães gathered in the hotel lobby, keeping a safe distance between one another. The remaining TAC members joined the meeting remotely. The same mixed meeting procedure was implemented for six RILEM Technical Committees that managed to have their meetings as planned.

In Guimarães, the establishment of the following TCs was approved by TAC:
• FBB: Fingerprinting bituminous binders using physico-chemical analysis, chaired by Bernhard Hofko
• DOC - Degradation of organic coating materials and its relation to concrete durability, chaired by Takafumi Noguchi
as well as the closure of the TCs:
• 261-CCF, Creep behavior in cracked sections of fiber reinforced concrete, chaired by Pedro Serna
• SHE, Self-healing concrete – Its efficiency and evaluation, chaired by Feng Xing.

At the last Spring Convention, it was also agreed that TC chairs will be very inclusive and will not refuse RILEM members to become member of their TC, even not when the TC has been running for a few years or if the proposed member has no background on the topic. All RILEM members should be allowed to learn about a new topic by joining a TC. Nevertheless, the TC chair can decide to refuse additional members in the final year of the TC.

As TAC chair, I want to congratulate all members of the TCs that were successfully closed in the last 12 months, for their hard work and contribution. I also want to welcome on board the members of the recently established TCs and wish them all good work.

My final remark is about the way forward, especially for the next 12 months. RILEM is providing commercial software licenses to all TC chairs to give them the opportunity to hold TC meetings in remote mode. This initiative should guarantee the ongoing activities of our committees. The next RILEM official gathering, the 74th RILEM Annual Week in Sheffield in August 2020, has been recently announced as a virtual event. I therefore expect TAC members to meet on that occasion, even though not in person.
The world is re-shaping and business will not be the same. I look forward to writing the editorial for the 2020-2021 RILEM report, so that I can announce the establishment of new TCs and celebrate the achievements of the ongoing TCs. Until then, keep safe and hold on there!

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An overview of the 3rd RILEM Spring Convention and Conference (RSCC2020)

Guimarães, Portugal, 10-14 March 2020

The third edition of the RILEM Spring Convention and Conference (RSCC2020) was caught right in the middle of the hurricane caused by the COVID-19 outbreak. During the previous couple of weeks, the attitude was essentially characterized by the cautious follow-up of all international developments, together with the establishment of precautionary measures, but still in a context of full freedom of action and zero cases in Portugal. Over the course of one week, a strong change on the general attitude by European authorities took place, characterized also by the prescription of preventive confinement to all citizens and the closing of the borders.

On Monday 9th March there were already about 100 participants involved in different activities in Guimarães, including two TC Meetings, one *fib* Committee meeting and one SARCOS (Self-healing As prevention Repair of COncrete Structures) PhD and ECI associated event. Tuesday 10th, the second and very important day for the activities by RILEM (including TAC, DAC, DEV, EAC and two other TCs), started with the effects of the initial measures by the Portuguese authorities towards the full lock-down, with the closing of the University of Minho. Eventually the entire country was under full lock-down at the onset of the following week. The same measures were being implemented in most of the European countries.

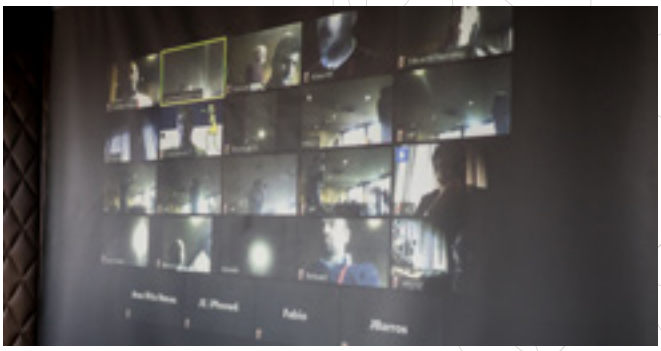
Despite the adversities, which led to the cancellation of some delegates and the closure of all public venues, participants kept an extremely positive spirit and RSCC2020 made it! In a very short time, the RSCC2020 organisers turned the event into an online conference, allowing delegates to present in remote mode from all corners around the world… and it was a great success! But let's start from the beginning.

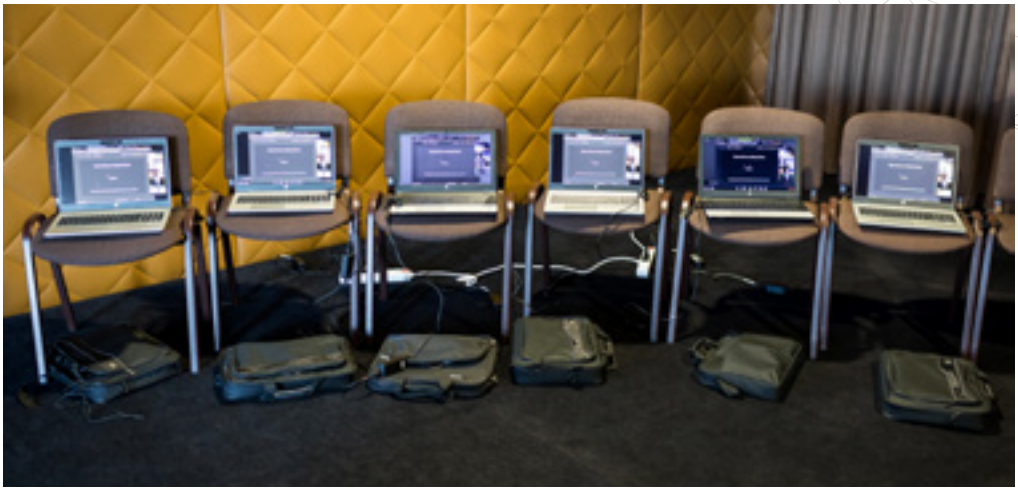
The RSCC2020 was scheduled to open at 9 AM on Tuesday 10th March at the Guimarães Campus of the University of Minho, Portugal. As mentioned before, on Monday 10th March, more than 100 participants had showed up in person at the registration desk of the event therefore cancelling was not an option when on the early morning of Tuesday, at around 8.30 AM, the Rector of the University of Minho, following the local Government restrictions emanated on that same morning, decided to close the campus. The Vila Flor Cultural Centre, the venue of the conference on Wednesday 11th, Thursday 12th and Friday 13th, had to follow the same restrictions, which were extended to all public facilities.

All these restrictions were caused by a resilient virus that was challenging the human society and causing troubles and sorrow for the first time, with unpredictable consequences and impacts.

But resilience was also the spirit of the RSCC2020 organisers that showed an impressive capacity to promptly recover from a difficult situation. Everyone was committed to push the young series of "RILEM Spring Convention" forward in its inception, although acknowledging that this third edition would be strongly marked by the unusual context and environment. The great majority of the RSCC2020 events took place in remote mode, organised literally on the spot, with not much time available, thanks to the non-stop activity of the event organisers and technicians and their knowledge of the appropriate technology. For the first (and probably not last) time, a RILEM event was streamed live including all its sessions and connecting speakers and delegates in remote mode from all over the world.

The conference rooms were almost empty. For safety reasons, delegates already accommodated in Guimarães were asked to try the remote tools made available to follow the event and interact with the presenters, while enjoying the good weather, in open air, of the UNESCO World Heritage city of Guimarães. Speakers were asked to attend their session in person to present their work. The speakers that were not in Guimarães connected to give their presentations remotely.
A few delegates were scattered in the conference room at a safe distance between each other. They asked questions to the speakers. Also remotely connected participants were given the opportunity to ask questions using user-friendly and networking technologies. The same procedure was implemented for all RILEM Standing Committee meetings, i.e. EAC, DAC, TAC, DEV and Bureau, that met on Tuesday 10th and Wednesday 11th March. Some of the RILEM officers were in Guimarães and others joined remotely. The following RILEM Technical Committees managed to have their meetings at the RSCC2020 as scheduled, with some TC members physically in Guimarães and others joining remotely:





Virtual conference mode! Courtesy of RSCC2020.

- 281-CCC, Carbonation of concrete with supplementary cementitious materials
- 275-HDB, Hygrothermal behaviour and Durability of Bio-aggregate based building materials
- MPA, Mechanical properties of alkali-activated concrete
- CCH, Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete-Reinforcing Steels
- 270-CIM, Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice
- CCS, Early age and long-term crack width analysis in RC Structures.

The RILEM Standing and Technical Committee meetings used a commercial remote-meeting platform which proved effective. All RILEM TCs mentioned above have now access to a license with this software and they can continue to use this license for the upcoming meetings, free of charge. The RILEM secretariat is giving the same opportunity to all RILEM Technical Committees and their members by purchasing more licenses.

One of the iconic buildings of the campus of the University of Minho, Guimarães, Portugal, venue of the 2020RSCC. Courtesy of RSCC2020.

Prof. Eduardo Pereira, one of the conference organisers, setting up the technology.

The feedback from speakers and participants was very positive:

Dr Mija Hubler, 2020 Colonnetti medallist, keynote speaker: *It was interesting and new, I would say. It was a strange presentation as I could not see the audience all the time. The only thing that would have been nice is to meet people there in person, because I was really excited to see the community people that had already travelled there. It would have been nice to go for dinner with them. Everybody appreciates social events at conferences so that is the only sad part.*

Dr Branko Šavija, 2020 Colonnetti medallist, keynote speaker: *I was very pleasantly surprised that the organisers managed to organise everything so functionally in such a short notice. I think this shows us possibilities for the future. Without any doubt, it is better after your talk to discuss in person your research with the other conference delegates, but the RSCC2020 organisers did a very good job. I am not disappointed! We should all applaud them for what they did in such a short notice.*

Dr Guang Ye, Chair of TC MPA: *The kick-off meeting on 11 March attracted 25 TC members in the online meeting. It is about 50% of the total membership of the TC. Overall, the quality of the connection was good. The meeting was interrupted only once. We sent a new invitation and continued the meeting within 3 minutes. The discussion between TC members was also very active. We would like to thank the RILEM secretariat and conference organization for the kind support, to make our TC meeting possible in these special circumstances.*

The streaming on YouTube of all sessions was accessed by thousands of viewers. The organisers confirmed that the average number of people simultaneously watching the streaming sessions was around 400 for the Auditorium room and 100 for the thematic session rooms. None of the 10 keynote presentations was cancelled, 4 delivered in person from Guimarães and 6 in remote mode:

Plenary session on Wednesday 11 March

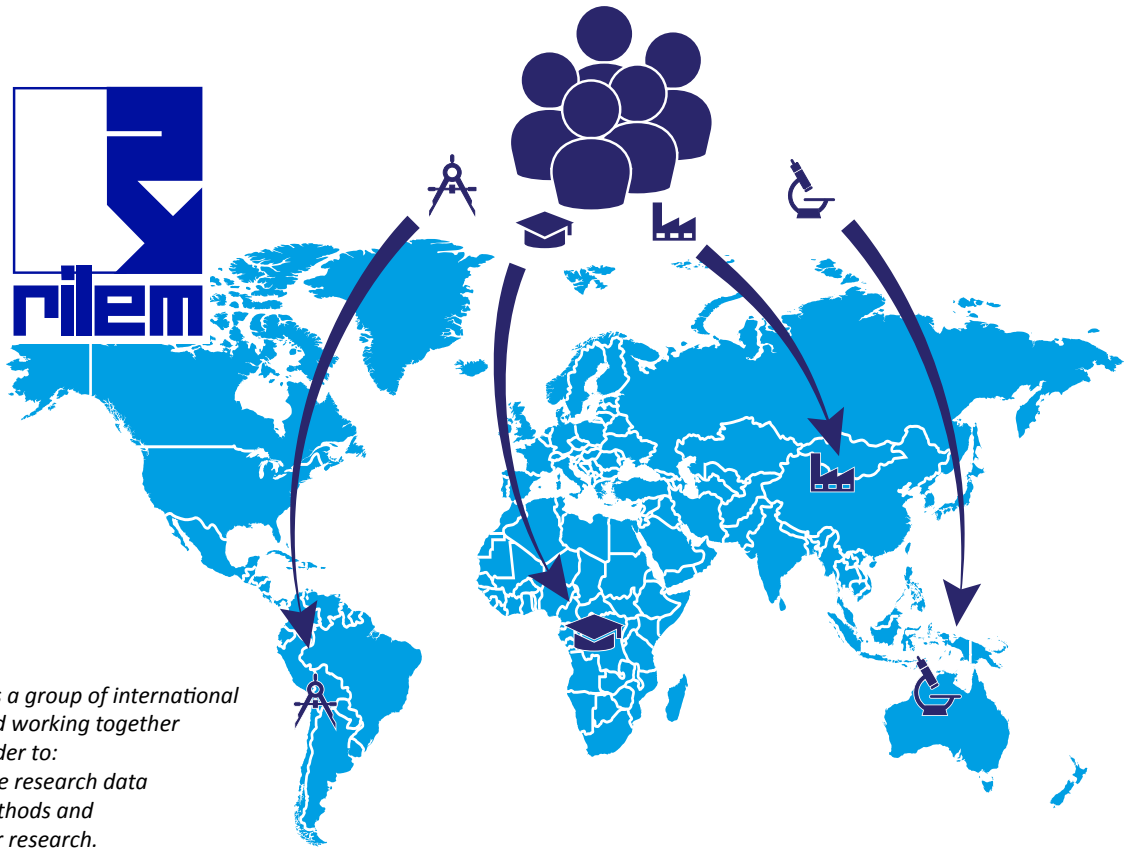
1. Testing techniques and numerical models for understanding and development of cementitious materials, Branko Šavija, 2020 Colonnetti medallist (in remote)
2. Modeling long term deformations of concrete: creep, shrinkage and cracking, Mija Hubler, 2020 Colonnetti medallist (in remote)
3. Rediscovering earth as a building material: old and new construction, Paulo Lourenço (in remote)
4. Environmental assessment: from incremental to radical decision making, Arpad Horvath (in person)
5. Practical solutions for CO_2 reduction from cement and ongoing research needs, Karen Scrivener (in person)

Plenary session on Thursday 12 March

6. Ultra High Durability Concrete: upgrading the concept and durability-based design of reinforced concrete structures exposed to extremely aggressive environments, Liberato Ferrara (in remote)
7. Greening the grey: recent advances on sustainable cementitious composites, Enzo Martinelli (in remote)
8. Self-healing concrete research in the European projects, SARCOS and SMARTINCS, Nele De Belie (in person)
9. Rheology and processing of cement-based materials, Nicolas Roussel (in remote)
10. Challenges, opportunities and potential solution strategies for environmentally and socially responsible urban development of megacities in Africa, Wolfram Schmidt (in person)

Despite the struggles to make all happen, as well as some understandable concerns about the decision to maintain the original schedule, the main message from this event goes beyond the technical topics discussed during the conference, i.e. “Ambitioning a sustainable future for built environment: comprehensive strategies for unprecedented challenges”. The lesson to take home is about the capacity to adapting to reality instead of fighting against it, and that our great power is to stay together, have hope and determination. However this was a minor test, compared to what is yet to come...

Technical Committees (TCs): the heart of RILEM



A Technical Committee is a group of international experts around the world working together in a particular field in order to:
1) assemble and evaluate research data
2) harmonise testing methods and
3) suggest new topics for research.

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 that has the role of co-ordinating and monitoring the activities of its TCs and advising the TAC. Each Cluster is chaired by a Cluster convener.

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.

Can I be a TC member?

Any RILEM member can become a TC member. At the last Spring Convention, it was also proposed that TC chairs should be inclusive and not refuse any request from RILEM members to become part of their TC, even though the TC could have been running for a few years or if the interested member is considered to have no background on the topic. This proposal was made in the spirit of encouraging all RILEM members to engage in new topics by joining TCs. RILEM would like to remind everyone that its young members, like PhD students and Affiliate members, are strongly encouraged to join a TC.

I am a RILEM member. How can I join a RILEM TC?

You can submit the registration form available on the RILEM website, or you can contact by email the chair of the TC you would like to join, or you can send an email indicating the TC you would like to join to RILEM Management Assistant, Ms Fanta Sylla.

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.

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; citing a sentence from Roberto Torrent, 2016 RILEM Honorary member, *"It is like for a young player to have the opportunity to play with Pelé, Maradona or nowadays with Messi".* 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.

Expected achievements (deliverables) of a TC

Each TC might produce at the end of its lifespan one or some of the following:

- A state-of-the-art report (STAR)
- One or more recommendations for test methods or construction practice
- Conference or workshop proceedings, if organised by the TC
- Technical reports and other educational material.

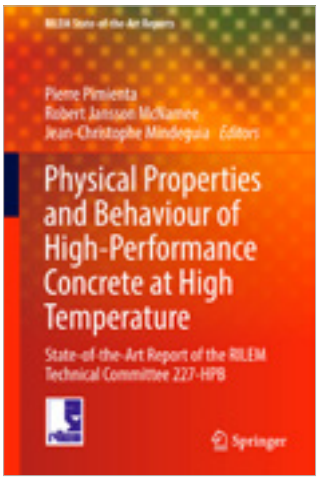
RILEM Publications

The mission of RILEM is "to advance scientific knowledge related to construction materials, systems and structures and to encourage transfer and application of this knowledge world-wide". This mission is achieved through the outstanding work of the RILEM Technical Committees and the dissemination of their outcomes as RILEM publications.

Publications given for free at the RSCC2020. Courtesy of RSCC2020.

State-of-the-Art reports (STAR)

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. Since 2009, RILEM State-of-the-Art reports are published by Springer and they are indexed by SCOPUS, Google Scholar and SpringerLink.
One can find the unedited version of each RILEM STAR, as PDF «unedited version» and download it for free from the RILEM web page.



Cover page of STAR of TC 227-HPB. Courtesy of Springer.

Recently, RILEM has initiated the series of *STARs in a Nutshell.* These documents should not be considered as a summary of the exhaustive work of the RILEM Technical Committees, but more like a brief overview of the contents available in the STAR. The purposes of these "STARs in a Nutshell" are:
1. To provide some initial guidance to a non-expert reader
2. To inspire more comprehensive reading of the STAR
3. To clarify the relevance of the contents before downloading or purchasing the full document for further details.

The two "STARs in a Nutshell" published in 2019 are presented in this report. They can also be downloaded for free from our website.

Proceedings

RILEM has been organising symposia and workshops since its foundation, with more than 100 proceedings published by RILEM Publications SARL. A quick glance at our website shows the diversity, importance and international scope of the topics. All proceedings published by RILEM can be downloaded for free (even for non-RILEM members) from the RILEM website. If you are not a RILEM member, you need to create a "registered user" account (free of charge).
The proceedings that are not published by RILEM Publications S.A.R.L. are published by Springer and they can be purchased online. There are currently 30 volumes in this RILEM Bookseries, available here.

Cover page of RILEM Proceedings PRO 133.
Courtesy of RILEM Publications S.A.R.L.

Materials and Structures

Materials and Structures, the flagship publication of RILEM, provides a unique international and interdisciplinary forum for new research findings on the performance of construction materials. A leader in cutting-edge research, the journal is dedicated to the publication of high-quality, original papers examining the fundamental properties of building materials, their characterization and processing techniques, modeling, standardization of test methods and the application of research results in building and civil engineering. *Materials and Structures* also publishes comprehensive reports and recommendations prepared by the RILEM Technical Committees.

Cover page of RILEM flagship publication *Materials and Structures / Matériaux et Constructions* (M&S).
Courtesy of Springer.

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 free to be downloaded.

Recommendation of RILEM TC 237-SIB on fragmentation test for recycled asphalt. Courtesy of Springer.

RILEM Technical Letters

RILEM Technical Letters was launched in March 2016 as a sister journal of RILEM's flagship, the 50-year old *Materials & Structures* journal, published by Springer/Nature. *RILEM Technical Letters* is published as a Diamond Open Access journal available online free of charge. The articles are submitted on invitation by the Editorial Board. Many articles are technical reports of the activities of the RILEM TCs. *RILEM Technical Letters* has been recently accepted for inclusion in Scopus and will be added to the database shortly. The acceptance to this prestigious bibliographic database follows a high-quality evaluation process by an independent board of experts (Scopus Content Selection and Advisory Board).

RILEM
technical letters

Logo of *RILEM Technical Letters*.
Courtesy of RILEM Publications S.A.R.L.

STAR in a Nutshell: TC 211-PAE

"Performance of Cement-Based Materials in Aggressive Aqueous Environments"

Concrete is a multiphase, porous, strongly basic material. The pH of the interstitial solution is approximately 13 which is beneficial and essential to protect embedded steel from corrosion. The characteristics of the pore network, dimensions (usually between 10-9 and 10-5 m) and connectivity of the capillary porosity determine the transfer of aggressive species inside the matrix. In the case of aqueous environments, the main form of degradation relates to the alteration of the hydrated cement compounds due to ion exchanges, additions, or substitutions.
The chemical reactions and physical mechanisms lead to a breakdown of the matrix microstructure and weakening of the material. The most common evidences of these degradation processes are i) cracks due to crystallization pressure and/or ii) strength loss and disintegration due to decalcification.

All aqueous solutions should be considered aggressive to cement-based materials, from pure (ion-free) waters (leading to leaching) to highly saline solutions (leading to ion addition and exchange reactions). Here, the emphasis is on the following groups of aggressive agents: 1) sulfates; 2) magnesium, 3) pure waters and strong acids, 4) ammonium nitrate and 5) organic acids.

1. External sulfate attack (ESA) often arises from an increased sulfate concentration in the service environment, as it is the case when concrete structures get in contact with sulfate-bearing soils and groundwaters, seawater and wastewaters. The effects of the chemical reactions between sulfate and solid hydration compounds of cement is generally the formation of expansive products that lead to cracks.

2. While sodium chloride is the dominant salt in marine waters which is detrimental for reinforcement corrosion, there is also a substantial amount of magnesium sulfate. The attack by the magnesium ion is particularly noteworthy, as it can cause a complete disintegration of the C-S-H in the long term. Damage in real structures manifests in the form of loss of adhesion and strength, rather than expansion and cracking that is commonly observed in laboratory tests.

3. Highly alkaline Portland cement is easily attacked by pure water and acidic solutions. The attack by acidic waters occurs more often than in the past because of growing urban and industrial activities. Pure or low mineralized water attack becomes crucial in the durability and safety of major concrete facilities and of water-conveying pipes and dams. The degradation is due to the leaching of cementitious materials, resulting in higher porosity and loss of strength.

4. Even though ammonium nitrate, a commonly used fertilizer, may cause severe degradation in fertilizer factories or in storage silos, it still represents a very scarce risk for concrete structures. Ammonium nitrate is actually used in laboratories to simulate leaching in accelerated conditions. The high aggressiveness of its attack is not only due to the high solubility of salts, but also (and first) to the affinity of the ammonium ion for the calcium-bearing phases of the cement matrix and to an additional acid-base reaction with NH_4^+/NH_3. Concentrations used in lab tests are very high, around 6 mol/L. Lower concentrations mean far less aggressive attacks. Ammonium nitrate solutions produce rapid decalcification due to the high solubility of its calcium salts. Degradation reactions related to ammonium nitrate solutions are swift and severe.

5. The effluents from agricultural and agrofood industries have complex compositions but share some common characteristics: the content of complex organic compounds and a large population of micro-organisms. The metabolism of the micro-organisms produces organic acids, whose attacks are of variable intensity but cause the progressive deterioration of concrete together with the formation of biofilms on its surface.

In recent years, models have been developed specifically to address sulfate attack, acid exposure, and calcium leaching. Whereas a model for chloride corrosion relies largely on a single transport parameter, reliable models for other degradation mechanisms presented above must also account for the effects of changes within the microstructure. A fully coupled thermal-hydro-mechanical (THM), multi-ionic chemical model involves numerical and computational efforts that are challenging. However, progress has been made since the publication of this STAR. Some RILEM Technical Committees are currently focusing on these aspects. The goal of implementing a complex transport, chemistry and mechanics in a single model is reachable and getting closer and closer.

The review of test methods to assess the performance of cementitious materials in aggressive aqueous environments, as well as test methods which can be used to characterise and rate relative performance (long term predictions), show the existence of many standard and non-standard tests. Parameters such as the scale of the test method, physical state of the attacking medium, nature of counter ions, the pH and concentration of the solution, temperature, rate of replenishment, mechanical action, alternate wetting and drying, alternate heating and cooling, pressure, etc. should be carefully selected. The measured degradation marker plays a crucial role and often a combination of multiple relevant indicators is necessary.

There are degrees of arbitrariness in turning the theoretical information about aqueous attacks into specifications or codes for practical purposes. The engineering community is still awaiting reliable tests for many concrete durability properties for performance prediction, mathematical models of deterioration that can be applied in practice, and a probabilistic approach to durability design.

Related documents:

1. *Recommendation of RILEM TC 246-TDC: Test methods to determine durability of concrete under combined environmental actions and mechanical load,* Materials and Structures *50 (155).*
2. *Beushausen H., Fernandez-Luco L. (eds.) Performance-Based Specifications and Control of Concrete Durability - State-of-the-Art Report of RILEM Technical Committee 230-PSC (2015).*

STAR in a Nutshell: TC 228-MPC

"Mechanical Properties of Self-Compacted Concrete"

Self-Compacting Concrete (SCC) can be considered as a new type of high-performance material of a different approach to mix design and rheological characteristics when compared to conventional concrete (in this report referred to as **vibrated concrete VC**). It offers a valuable solution for accelerating the placement rate and reducing labour demand needed for placing concrete. Although SCC has been used in actual structures for a while, until recently it was not fully clear whether existing designing codes for structural design could be fully applied to SCC. In order to give a detailed answer to this issue, this state-of-the-art reviewed the properties of SCC with respect to mechanical behaviour, stress strain relations, bond properties, etc.
An extensive database, containing the results of **mechanical properties** of fresh and hardened SCC has been generated and analysed. It originates from numerous (around 250) journal and conference papers published between 1990 and 2011. This database also includes information on the mixture proportion and design. Only mixtures with slump-flow values within the limits defined by EN206 (550 to 850 mm) were considered. The following major considerations have been made:

1. All types of cement are applied in SCC mixtures.

2. The Water/Cement values are between 0.19 and 2.73, with a mean value of 0.54.

3. The high powder content needed for SCC, compared to VC, is obtained by increasing the cement content or more often by increasing the amount of power-type additions. These are commonly instance pozzolanic materials like limestone filler, fly ash, blast furnace slag and silica fume. However, in some cases also marble powder, glass powder, rice husk ash, metakaolin, volcanic ash and granite powder are used.

4. The total paste volume of a SCC mixture is, in most cases, higher (mean value around 370 l/m^3) than that of a VC mixture (290l/m^3).

5. Results originating from the literature seems to indicate that the conversion factor fccyl /fccub between compressive strength determined on cylinders (fccyl) and on cubes (fccub) may be higher for SCC than reported for VC: for the latter it is generally situated within the region of 0.7 to 0.9; for the former, it tends to situate beyond the upper limit of 0.9. No dependency on the compressive strength was noticed.

6. Water/Cement and cement strength class are the principal factors influencing the compressive strength, as it is the case for VC.

7. At a constant Water/Cement ratio, a higher Cement/Powder ratio generally leads to a lower strength.

8. 1% increase of air content generates a decrease of about 4 MPa of the compressive strength of SCC.

9. Addition of limestone filler in SSC results in higher peak strains and toughness than VC.

10. An increasing trend of direct, splitting and flexural tensile strength is noticed for increasing strength of SCC samples.

11. Analysis of the data available in the database shows that the modulus of elasticity of SCC seems to be very similar to VC.

12. On average, the strength loss after heating of SCC is comparable to VC. The probability of spalling of SCC seems higher compared to VC, although some conflicting results are found as well.

13. Overall, it can be confirmed that SCC cast in-situ can provide similar or even slightly better properties compared to cast in-situ VC.

With the appearance of SSC as a valuable alternative for VC, some of the established **stress-strain** relations have to be re-evaluated, because of the significant changes in the paste volume and binder composition and their influence into the viscoelastic properties. On this regard, the main points found in the literature are:

1. Creep coefficient and specific creep seem to be generally higher (5-10%) for SCC compared to VC with the same binder composition.

2. The use of Ground Granulated Blas-Furnace Slag (GGBFS) and fly ash can result in a decrease of the creep coefficient.

3. The influence of the strength-gain rate on the creep coefficient needs further research.

4. Autogenous shrinkage in SCC increases with increasing cement content and decreasing W/P by vol, as it happens in VC.

5. SCC should be more susceptible to plastic shrinkage cracking than VC. Results in the literature are, however, scarce and more research is needed.

6. Current (up to 2014) numerical models are designed for VC and do not take into account the influence of paste volume. An adaptation of these models to SCC is necessary.

The bulk of the available literature agrees that **bond properties** of SCC to embedded reinforcement, pre-stressing strands and hardened concrete are higher than those of VC, due to the different rheological properties of the former. These are the major conclusions on this topic:

1. Static stability of SCC is critical in reducing the top-bar effect to embedded reinforcement and prestressing strands.

2. To avoid entrapment of air-voids during casting, plastic viscosity should be kept below 80 Pa.s and t50 below 6 seconds.

3. SCC used as a repair material develops greater strength to existing surfaces than repair overlay made with VC.

When the proportions of coarse aggregate (size and shape) or paste content of SCC mixtures significantly differ from those of VC, some researchers have observed a difference in engineering properties such as shear and bond strength. This observation has triggered the need to investigate the **structural behaviour** of SCC. The final remarks on this matter are:

1. SSC structural elements seem to be characterised by an increased value of the strain at peak, reduced value of the axial stiffness and increased value of the flexural strength, with respect to VC.

2. Ductility of SCC is in general higher than that of VC. If the structural element if confined by means of stirrups, SCC shows larger ductility.

3. The structural behaviour of reinforced structural elements under flexure made of SCC is very similar to that of the corresponding elements made with VC. Conventional design predictive models and equations proposed for VC can be applied also to SSC.

4. The shear strength of SSC is around 10-15% lower than that found in VC. This difference disappears when considering beams with stirrups.

Related documents:

1. *Proceedings Pro100: 8th International RILEM Symposium on Self-Compacting Concrete (2016) Edited by Kamal H. Khayat*
2. *Proceedings Pro090: Rheology and processing of Construction Materials – 7th RILEM International Conference on Self-Compacting Concrete and 1st RILEM International Conference on Rheology and Processing of Construction Materials (2013), Edited by N. Roussel and H. Bessaies-Bey*
3. *Durability of Self-Compacting Concrete (2007) State-of-the-Art Report of RILEM Technical Committee 205-DSC*
4. *Casting of Self Compacting Concrete (2006) State-of-the-Art Report of RILEM Technical Committee 188-CSC*
5. *Self-Compacting Concrete (2000) State-of-the-Art Report of RILEM Technical Committee 174-SCC*

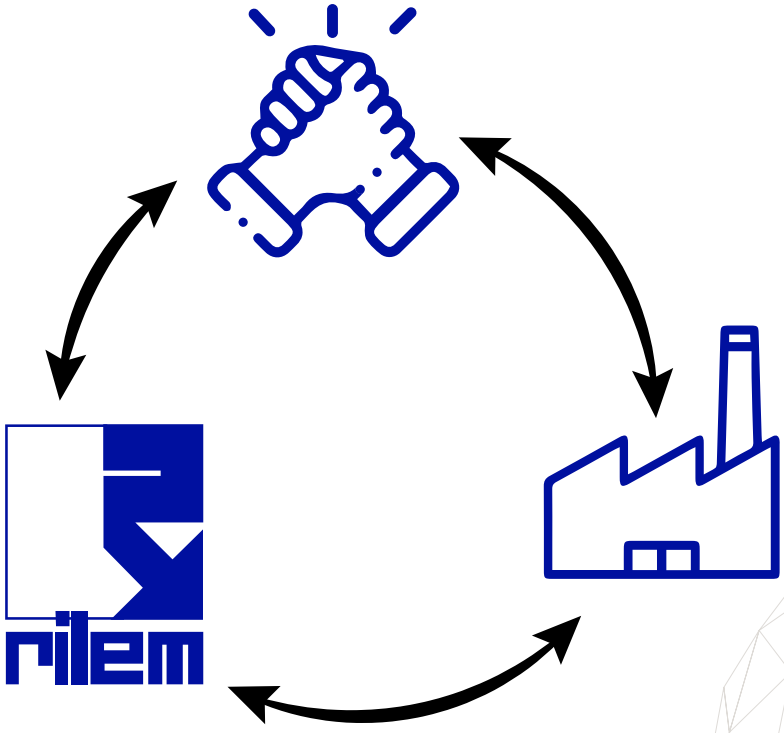
Industry involvement in RILEM

Out of the 1474 current RILEM members, 1137 are members of one or more Technical Committees. They are as mentioned last year by the TAC chair in her editorial *"the heart of RILEM, or maybe rather the hands and feet"* carrying out laboratory tests and experiments and writing reports and recommendations.

The input of the many PhD students and professors working as TC members is undeniabley invaluable.

The contribution of TC members from government bodies, research centres and industrial institutions is also crucial. Without the support of these members, RILEM could not exist. It is in recognition of the vital collaboration with the construction sector that RILEM identified "establishing better links with the industry" as one of the five key actions of the RILEM Strategic Roadmap drawn up in 2014.

One consequence of the implementation of this key action is the establishment in 2016 of TC 276-DFC: Digital fabrication with cement-based materials, chaired by Nicolas Roussel. This TC counts amongst its members representatives of the following businesses and institutes: Magnel-Vandepitte Laboratory for Structural Engineering and Building Materials (Belgium), Knauf Gips (Germany), Salini Impregilo Spa (Australia), SIKA (France), NIST (USA), Eurovia Management Centre de recherche (France), SCG Cement company (Thailand), Lafarge centre de recherche (France), Deutscher Beton-und Bautechnik-Verein E.V. (Germany), Cemex (Switzerland) and China Building Materials Academy (China).



Another example is the creation in 2018 of TC 282-CCL: Calcined clays as supplementary cementitious materials, chaired by José Fernando Martirena-Hernandez. The involvement of the cement industry in this TC is crucial, and RILEM acknowledges the contribution of Heidelberg Cement Technology Center (Germany), LafargeHolcim (France), Cementir Holding S.p.A. (Denmark), Aalborg Portland Group (Denmark), Cementos progreso (Guatemala), LMDC (France), Arup Group (UK), CDAC-SECIL (Portugal), VITO (Belgium) and LNEC (Portugal).

The industry commitment within RILEM activities is also shown by the number of TC chairs (12) and Deputy Chairs (10) coming from non-academic institutions, like TC 258-AAA: Avoiding Alkali Aggregate Reactions in Concrete - Performance Based Concept. This TC, started in 2014, has both Chair (Børge Johannes Wigum) and Deputy Chair (Jan Lindgard) coming from the sand and concrete supplying sector (for the former) and the cement and concrete research (for the latter). It has also a significant number of members from non-academic institutions: LNEC (Portugal), VDZ (Germany), Geological Survey of Norway (Norway), Mott MacDonald (UK), TNO (Netherlands), VTT Technical Research Centre of Finland (Finland), WSP New Zealand Ltd (New Zealand), RJ Lee Group (USA), Institute of Fundamental Technological Research (Poland), Port and Airport Research Institute (Japan), Smart Minerals GmbH (Austria), DESEK (Brazil), EMPA (Switzerland), SINTEF Building and Infrastructure (Norway), BAM (Germany), RISE (Sweden), Norwegian Public Roads Administration (Norway), Heidelberg cement northern Europe (Norway) and RSK Environment Limited (UK).

RILEM has also recently enhanced its collaboration with the Asian countries, where the construction industry is in continuous expansion. Two TCs have significantly contributed to the establishing of further alliance with the industrial sector in that part of the world. These are:

•284-CEC: Controlled expansion of concrete by adding MgO-based expansive agents taking the combined influence of composition and size of concrete elements into consideration, created in 2018 and chaired by Jiaping Liu with members from: Jiangsu Research Institute of Building Science (China), LNEC (Portugal), China Three Gorges Corporation (China), EMPA (Switzerland), Materials Advanced Services Ltd. (Argentina), Cementos Progreso SA (Guatemala), China Construction 8th Engineering Division Co. Ltd. (China) and Jiangsu Sobute New Materials Co. Ltd. (China)

and

•DCM: Long-term durability of structural concretes in marine exposure conditions, created in 2019 and chaired by Kefei Li with members from: Centro de Investigación y de Estudios Avanzados del IPN Unidad Mérida (Mexico), Central Research Institute of Building and Construction - MCC (China), Norwegian Public Roads Administration (Norway), Arup Group Ltd (UK), NBRI (Israel), Holcim Group Support Ltd (France), Materials Advanced Services Ltd. (Argentina), LNEC (Portugal), HKSARG Civil Engineering and Development Dept (China) and Fourth Harbor Engineering Institute - Co. Ltd (China).

Last but not least, a TC with an outstanding group of industry members: TC 281-CCC: Carbonation of concrete with supplementary cementitious materials, created in 2017, is chaired by Nele De Belie and by its Deputy Susan Bernal-Lopez. Its members come from: ZAG (Slovenia), Lafarge (France), Amphos21 (Spain), BAM (Germany), EMPA (Switzerland), LNEC (Portugal), Holcim (Italy), CTLGroup (USA), Paul Scherrer Institute (Switzerland), Belgian Nuclear Research Centre SCK-CEN (Belgium), VITO (Belgium), LEMIT (Argentina), TFB AG (Switzerland) and Heidelberg Cement Technology Center GmbH (Germany).

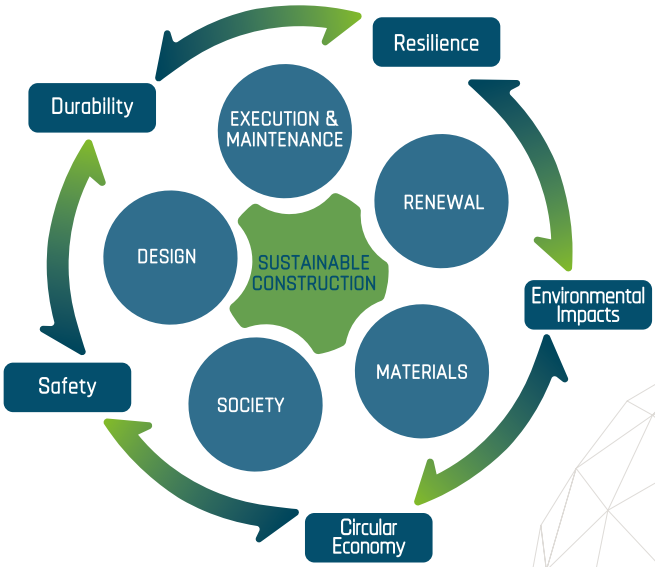
A global call for sustainable developments of the built environment

GLOBE, Global consensus on sustainable developments of the Built Environment

Nothing less than a transformative and united worldwide effort from all stakeholders and in particular those of the construction sector is required for human society to be successful in sustainable development, and in the mitigation of the disastrous consequences of climate change at global and local scales.

Global population growth and rapid urbanization demand enormous construction activities and materials use. Within the next ten years, the overall global land use requirement of the built environment is expected to double. In addition, it is expected that in more developed economies infrastructure and maintenance of structures will significantly increase. Current practices for the management of construction and structures are far from sustainable. If these are not changed, the emissions from the construction sector alone will jeopardize the achievement of the objectives of the Paris agreement.

Redirecting the construction sector comprises a major challenge which necessitates strong and persistent political focus. The construction sector is organized in a decentralized way with a vast number of organizations and participants. There is little or no integrative organization between service providers or owners and clients. In addition, applied technology enhancements are incremental and international standards, codes, and guidelines that govern the design and construction of the built environment evolve too slowly to keep pace with the rapidly increasing of technological advances.



GLO*BE* draws the attention of societal decision makers to the need of new best practices to be implemented by all stakeholders and through all links of the value chains of the construction sector.
Major facilitators for this transformative change are identified as targeted improvements of codes and regulations, financial incentives together with research and education. Suggested operational instruments for design and integrity management of buildings and infrastructure include explicit consideration of circular economy, life cycle environmental impact assessments, increased use of advanced modelling and analysis methods as well as targeted utilization of new sensing, data processing and storage technologies.

GLOBE
Global consensus on sustainability in the Built Environment

In support of policy decision making at global and national levels the Joint Committee on Structural Safety is offering its assistance and suggests to establish a Global Task Force under the auspices of the Liaison Committee comprising experts from RILEM, IABSE, *fib,* CIB, ECCS, IASS, and joined by other relevant and committed international and national organizations that also support the GLO*BE* Consensus.
The subscribers of GLO*BE* fully appreciate that the built environment is much more than structures and infrastructures – it encompasses and involves society in general, the environment and a broad range of industries and professions. It is the intention that the GLO*BE* initiative shall evolve over time to account more holistically for all stakeholders of the built environment, and your contributions in support of this are sincerely invited and hoped for. Expression of support is possible through this link: GLO*BE* support. More information about GLO*BE* may be found at: http://globe.rilem.net

RILEM actively supports and hosts the GLO*BE* consensus.

About GLO*BE* – Global Consensus on Sustainability in the Built Environment

GLO*BE* was initiated at an interdisciplinary workshop held at Tongji University, Shanghai, China co-organized by members of the Joint Committee on Structural Safety (JCSS) and the International Joint Research Center for Engineering Reliability and Stochastic Mechanics (CERSM) at Tongji University. GLO*BE* has since been adopted by the JCSS and is supported by major international associations within the construction industry, including RILEM, IABSE, *fib*, CIB, ECCS and IASS.

The GLO*BE* working team operated under the direction of Prof. Michael Havbro Faber, President of the Joint Committee on Structural Safety and initiator of GLO*BE*, assisted by Dr. Dipl.-Ing. Wolfram Schmidt, from Bundesanstalt für Materialforschung und -prüfung (BAM).

Educational Activities Committee (EAC) courses

Karen Scrivener, EAC chair

Douglas Hooton, former EAC chair

Fanta Sylla, EAC secretary

The Educational Activities Committee (EAC) of RILEM aims to broaden the education of both PhD students and the professional community through promotion of interesting and informative courses and seminars on subjects of relevance to researchers working in specific areas. All RILEM activities in the field of education, like courses to which we grant scientific sponsorship, are coordinated and approved by EAC. Though RILEM EAC has only existed for a handful of years, our sponsored courses have been enjoyed by more than 2000 participants and about 200 teachers.

In August 2019, Douglas Hooton completed his mandate as EAC chair and passed on the torch to Karen Scrivener. Fanta Sylla, RILEM management assistant, joined EAC as secretary in March 2020.

Amongst the main features of the activities over the past months, it is important to highlight the conversion of many courses from “in person” to “virtual” due to the current COVID-19 situation. Amongst the features of the future events, we are glad to inform that EAC is currently working with the local organisers to put together a diverse doctoral programme the week before the RILEM Annual week in Mexico in 2021.

A list of the EAC courses offered over the last 12 months is presented below. Please visit the event page of our website for further details.

Date	Name	City	Country	Organizer
21/08/2019	Concrete technology – State of the art and future	Nanjing	China	Ole Mejlhede Jensen
09/09/2019	Advanced course on Modeling of Localized Inelastic Deformation	Prague	Czech Republic	Milan Jirásek
16/09/2019	17th SIIV International Summer School: Climatic changes and perspective of road	San Marino	San Marino	Andrea Grilli
21/10/2019	Corrosion Science & Corrosion Control for Infrastructure	Delft	The Netherlands	Erik Schlangen
18/11/2019	Advanced Concrete Technology Course	Chennai	India	Piyush Chaunsali
12/01/2020	EuroTech RILEM PhD School Concrete Life Cycle: From Cradle to Grave	Haifa	Israel	Kosta Kovler
03/02/2020	East African Student Seminar on Materials technologies for sustainable construction	Dar es Salaam	Tanzania	Wolfram Schmidt
10/02/2020	6th LC3-Doctoral School	Lausanne	Switzerland	Karen Scrivener
09/03/2020	Lowering CO2 emissions from cement and concrete through increasing the use of supplementary materials	Guimarães	Portugal	Karen Scrivener
14/03/2020	Computational methods for building physics and construction materials - LITE	Guimarães	Portugal	Eddie Koenders
14/03/2020	Durability-based design of advanced cement-based materials in aggressive environments: a holistic approach	Guimarães	Portugal	Liberato Ferrara
30/03/2020	Corrosion Science & Corrosion Control for Infrastructure (CSC2I)	Delft	The Netherlands	Dessi Koleva
02/05/2020	Online Workshop on "Recent Advances in Science and Technology of Concrete"	Chennai	India	Ravindra Gettu
11/05/2020	Chemistry of Cement and Concrete	Toronto	Canada	Doug Hooton
16/06/2020	Concrete Microscopy Course	Delft	The Netherlands	Oguzhan Copuroglu
06/07/2020	Computational Methods for Building Physics and Construction Materials - Online	Darmstadt	Germany	Eddie Koenders

Participants of the Doctoral Course "Advanced Concrete Technology", Chennai, India, Nov 2019. Courtesy of P. Chaunsali.

A moment in class during the course "Modeling of Localized Inelastic Deformation (LID 2019)", Prague, Czech Republic, Sept 2019. Courtesy of D. Ciancio.

Some of the participants and lecturers of the "East African Student Seminar on Materials technologies for sustainable construction", Dar es Salaam, Tanzania, Feb 2020. Courtesy of W. Schmidt.

Recently closed TCs

At the TAC meeting in Nanjing, China, in August 2019 and in Guimarães, Portugal, in March 2020, the TCs listed in the table below have been officially closed as they completed their work or reached the end of their lifespan.

Code	Title	Chair	Deputy Chair	TC opened in	TC closed in
251-SRT	Sulfate resistance testing	Véronique BAROGHEL-BOUNY	Esperanza MENENDEZ MENDEZ	2013	2019
253-MCI	Microorganisms-cementitious materials interactions	Alexandra BERTRON	Henk JONKERS	2013	2019
255-FRS	Fire resistance of concrete structures repaired with polymer cement mortar	Takafumi NOGUCHI	Kei-Ichi IMAMOTO	2013	2019
259-ISR	Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reactions	Victor E. SAOUMA	Leandro SANCHEZ	2014	2019
263-EEC	Environmental evaluation of concrete structures toward sustainable construction	Amnon KATZ	Guillaume HABERT	2012	2019
245-RTE	Reinforcement of timber elements in existing structures	Jorge BRANCO	Philipp DIETSCH	2011	2019
261-CCF	Creep behavior in cracked sections of fiber reinforced concrete	Pedro SERNA ROS	Sergio Henrique PIALARISSI CAVALARO	2014	2020
SHE	Self-healing concrete – Its efficiency and evaluation	Feng XING	Erik SCHLANGEN	2016	2020
247-DTA	Durability testing of alkali-activated materials	John PROVIS	Frank WINNEFELD	2012	2019
249-ISC	Non destructive in situ strength assessment of concrete	Denis BREYSSE	Jean-Paul BALAYSSAC	2012	2019

Some details of these recently closed TCs can be found in the 2018-2019 RILEM Technical Report or by visiting the page "Index of past TCs" on our website. A short summary of the recent publications that were not included in last year report and of the to-be-published-soon publications of some of these TCs is presented in the following lines:

251-SRT: Sulfate resistance testing,
Chair: Véronique BAROGHEL-BOUNY, Deputy Chair: Esperanza MENENDEZ MENDEZ
• External Sulphate Attack – Field Aspects and Lab Tests. RILEM Final Workshop of TC 251-SRT (Madrid - SPAIN, 2018), Editors: Menéndez Méndez Esperanza and Baroghel-Bouny Veronique (Eds.), Springer 2020.
• STAR in preparation.

253-MCI: Microorganisms-cementitious materials interactions,
Chair: Alexandra BERTRON, Deputy Chair: Henk JONKERS
• STAR in preparation.

255-FRS: Fire resistance of concrete structures repaired with polymer cement mortar,
Chair: Takafumi NOGUCHI, Deputy Chair: Kei-Ichi IMAMOTO
• STAR in preparation.

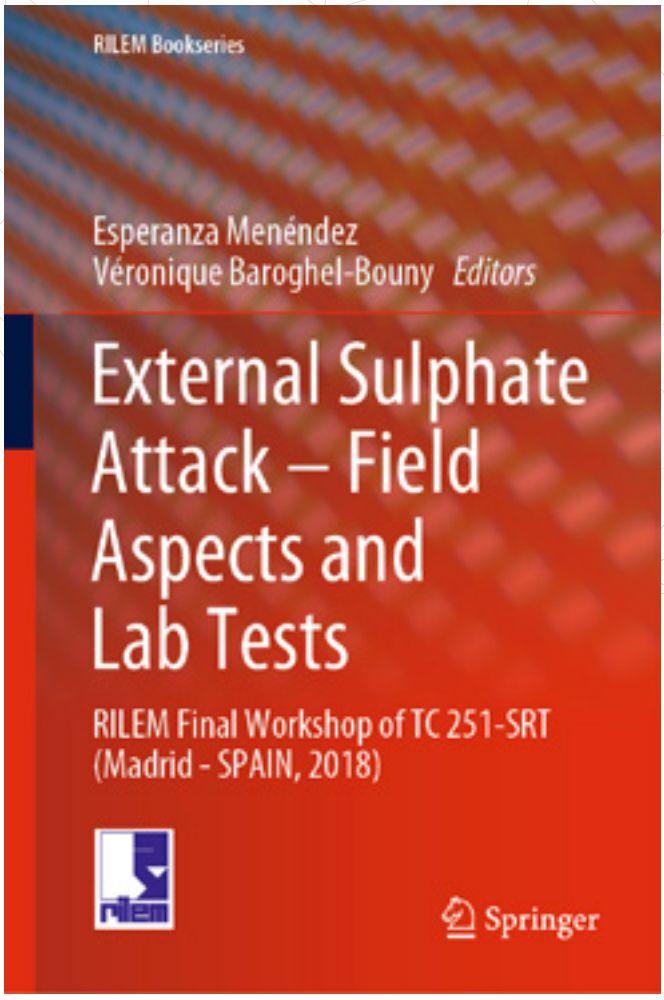
259-ISR: Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reaction,
Chair: Victor SAOUMA, Deputy Chair: Leandro SANCHEZ
• STAR will be available in August 2020.

245-RTE: Reinforcement of timber elements in existing structures,
Chair: Jorge BRANCO, Deputy Chair: Philipp DIETSCH
• STAR in preparation.

261-CCF: Creep behaviour in cracked sections of fibre reinforced concrete,
Chair: Pedro SERNA, Deputy Chair: Sergio CAVALARO
• STAR in preparation.

247-DTA: Durability testing of alkali-activated materials,
Chair: John L. PROVIS, Deputy Chair: Frank WINNEFELD
• Provis, J.L. et al. "RILEM TC 247-DTA Round Robin Test: Mix design and reproducibility of compressive strength of alkali-activated concretes," *Materials and Structures,* 2019, 52: #99.
• Gluth, G.J.G. et al. "RILEM TC 247-DTA round robin test: carbonation and chloride penetration testing of alkali-activated concretes," *Materials and Structures,* 2020, 53(1): #21.

249-ISC: Non-destructive in-situ strength assessment of concrete,
Chair: Denys BREYSSE, Deputy Chair: Jean-Paul BALAYSSAC
• STAR completed and in the process of being published by Springer.
• Recommendations on non-destructive in situ strength assessment of concrete published in June 2019 (open access publication available here).



Cluster A
Material Processing and Characterization

Foreword
- from Cluster A Convener,
  Daman K. PANESAR

There are currently nine RILEM Technical Committees that fall in Cluster A: Material Processing and Characterization. The Technical Committees advance knowledge and applications in the fields of emerging material processing technologies, characterization of composites, cement-based materials, aggregates, polymers and expansive agents. The specific focus areas of the technical committees include: the practical use of superabsorbent polymers in concrete (TC 260-RSC); creep behaviour of cracked fiber reinforced concrete (TC 261-CCF); rheological properties of cement-based materials (TC 266-MRP); reactivity of supplementary cementing materials (TC 267-TRM); hydrothermal behaviour of bio-aggregate building materials as well as durability behaviour of bio-aggregate based composites (TC 275-HDB); materials, rheological properties, processes, and applications of digital fabrication of cement-based materials (TC 276-DFC); reactive MgO-based expansive agents to reduce the risk of crack formation (TC 284-CEC); and the use of agro-based materials as cementitious additions in concrete and cement-based materials (TC AMC).

Over 200 RILEM members currently participate in Technical Committees that co-ordinated under Cluster A. The leadership and membership of these committees reflects an international representation. Meetings, workshops, and doctoral courses organized by the Technical Committees have been held around the world, and enable engagement, knowledge transfer, and networking opportunities for design engineers, industry professionals, research scientists, students and is also a starting point to attract new RILEM members. Research outcomes are disseminated to the broader community through the publication of: state-of-the-art reports (STAR), RILEM recommendations, results of round-robin tests, proceedings from international RILEM conferences, RILEM PhD course materials, and journal articles. Outcomes of the Technical Committee work is also used by standardization bodies to facilitate the development of codes and standards in the field of material processing and characterization.
I have had the honour to serve on the RILEM Technical Activities Committee (TAC) since 2018 and have been the Convener of Cluster A since 2019, previously held by Professor Barzin Mobasher.

Current TCs in Cluster A

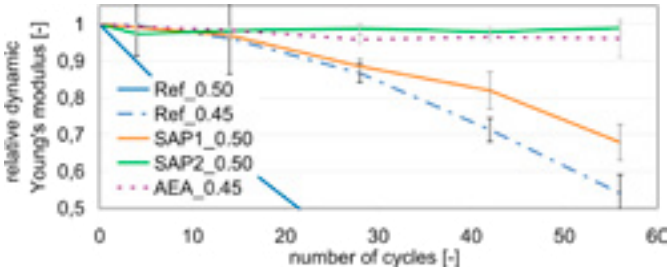
Code	Title	Chair	Deputy Chair	TC opened in
260-RSC	Recommendations for use of superabsorbent polymers in concrete construction	Viktor MECHTCHERINE	Mateusz WYRZYKOWSKI	2014
266-MRP	Measuring rheological properties of cement-based materials	Mohammed SONEBI	Dimitri FEYS	2015
267-TRM	Tests for reactivity of supplementary cementitious materials	Karen SCRIVENER	Ruben SNELLINGS	2015
275-HDB	Hygrothermal behaviour and durability of bio-aggregate based building materials	Sofiane AMZIANE	Florence COLLET	2016
276-DFC	Digital fabrication with cement-based materials	Nicolas ROUSSEL	Dirk LOWKE	2016
282-CCL	Calcined clays as supplementary cementitious materials	José Fernando MARTIRENA-HERNANDEZ	Manu SANTHANAM	2018
284-CEC	Controlled expansion of concrete by adding MgO-based expansive agents taking the combined influence of composition and size of concrete elements into consideration	Jiaping LIU	Ole Mejlhede JENSEN	2018
AMC	Use of agro-based materials as cementitious additions in concrete and cement-based materials	Said KENAI	Mike B. OTIENO	2018

Recommendations for use of superabsorbent polymers in concrete construction

260-RSC

Chair **Viktor MECHTCHERINE**
Deputy Chair **Mateusz WYRZYKOWSKI**
Activity started in 2014

Tea-bag method to test SAP absorption.
Materials and Structures (2018) 51:116.



Changes in relative Young's modulus during CIF test.
RILEM Tech Lett (2016) 1:81.

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.), but a considerable gap still exists between laboratory experience and application in the praxis of construction.

Relevance

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

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.
- Performing round-robin test to investigate the effect of SAP addition on plastic shrinkage.

Progress

- Boshoff W. et al. (2020) The effect of superabsorbent polymers on the mitigation of plastic shrinkage cracking of conventional concrete, results of an inter-laboratory test by RILEM TC 260-RSC, *Mater Struct,* 53: 79.
- Mechtcherine V. et al. (2019) Recommendations of RILEM TC 260-RSC for using superabsorbent polymers (SAP) for improving freeze–thaw resistance of cemen-based materials, *Mater Struct,* 52: 75.
- Wyrzykowski M. et al. (2018) Recommendation of RILEM TC 260-RSC: using superabsorbent polymers (SAP) to mitigate autogenous shrinkage, *Mater Struct,* 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, *Mater Struct,* 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, *Mater Struct,* 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, *Mater Struct,* 50:197.
- Mechtcherine V. (2016) Use of superabsorbent polymers (SAP) as concrete additive, *RILEM Technical Letters,* 10:81-87.

266-MRP

Measuring rheological properties of cement-based materials

Chair **Mohammed SONEBI**
Deputy Chair **Dimitri FEYS**
Activity started in 2015

Participants of the Round Robin Test on Comparison of Rheometers at IUT Bethune, France, in 2018. Courtesy of M. Sonebi.

Analysing results of the RRT on Comparison of Rheometers at IUT Bethune, France, in 2018. Courtesy of M. Sonebi.

Significance

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. Nevertheless, different rheometers deliver different results for the same mix design, and the reasons behind these differences are currently unknown. Additionally, uniform recommendation and guidelines on how to perform rheological testing and analysis are missing.

Relevance

The targeted users academics, testing laboratories, industrialists, practitioners, general public, Ph.D students and rheometer producers.

Goals

- To publish a state-of-the-art report on different aspects of measuring rheological properties of cement-based materials, including the main rheological properties, types of rheometers, rheological models and measurement artefacts.
- To develop a set of guidelines or best-practices.

Methodology

- Compiling existing literature and expert opinions.

Progress

- One-day feedback – Round Robin Test. Comparison of Concrete Rheometers: International Tests at the Artois University (IUT Bethune), 8 Nov 2019, FNTP, Paris, France.
- Feys D. et al. (2019), An overview of RILEM TC 266-MRP round-robin testing of concrete and mortar rheology in Bethune, France, May 2018, Proceedings of RheoCon 2019 and SCC 2019, 10p.
- M. Sonebi (2019) Activities of RILEM TC 266-MRP "Measuring Rheological Properties of Cement-based Materials" – State-of-the-art report, Keynote presentation during RheoCon 2019 and SCC 2019.
- Proceedings of the International RILEM Workshop on Rheological Measurements of Cement-based Materials - IRWRMC'18 (2018), Edited by C. Djelal, Y. Vanhove, RILEM Publications, ISBN: 978-2-35158-230-5.
- A measurement campaign comparing different concrete rheometers was performed in May 2018 in Bethune, France. The data is being analysed by all parties involved.
- Feys D. et al. (2018). Measuring rheological properties of cement pastes: most common techniques, procedures and challenges. *RILEM Technical Letters,* 2:129-135.
- Based on the STAR and expert opinions, recommendations will be prepared in 2020.

Tests for reactivity of supplementary cementitious materials

Chair **Karen SCRIVENER**
Deputy Chair **Ruben SNELLINGS**
Activity started in 2015

Group photo taken at the occasion of the 5th TC 267-TRM meeting in Leuven, Belgium. Courtesy of TC 267-TRM.

Significance

Supplementary cementitious materials (SCMs) are commonly used in concrete 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.

Relevance

The targeted users are academics, industrial scientists and standardisation committees.

Goals

• Proposing 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.

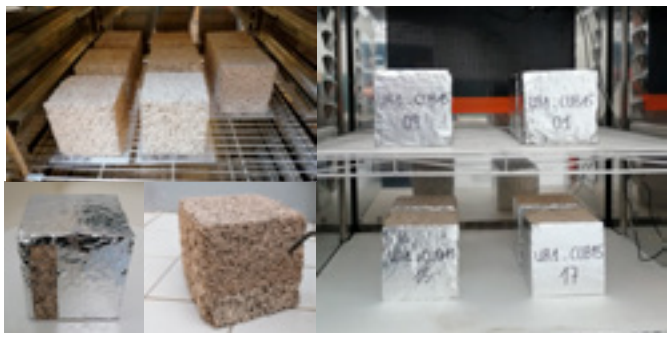
Progress

• Snellings R. et al (2019) Rapid, Robust, and Relevant (R3) Reactivity Test for Supplementary Cementitious Materials, *ACI Materials,* 166 (4): 155.
• Li X. et al (2018) Reactivity tests for supplementary cementitious materials: RILEM TC 267-TRM phase 1, *Mater Struct* 51: 151.
• Upcoming papers: Phase 2: R3 optimisation & robustness paper (in preparation), Phase 2: Lime reactivity strength test opt. & robustness paper (in preparation), Phase 3: publication of results (in preparation).
• Scrivener K. (2019) Tests for reactivity of supplementary cementitious materials, Presentation of TC 267-TRM work at the 73rd RILEM Annual Week, Nanjing, China.
• Dissemination in pre-conference workshops and doctoral courses: i. Hydration of cementitious materials/Supplementary Cementitious materials course 9/2019, Prague, Czech Republic; ii. LC3 course 2/2020, EPFL, Lausanne; iii. SCM course 8/2019, Nanjing, China; iv. Cement chemistry and sustainable cement-based technologies course 20/2020, Dar es Salaam, Tanzania.

275-HDB

Hygrothermal behaviour and durability of bio-aggregate based building materials

Chair **Sofiane AMZIANE**
Deputy Chair **Florence COLLET**
Activity started in 2016



Measurement of Moisture Buffering Value (MBV) of Hemp concrete at LGCGM / Université de Rennes 1 (France): drying, sealing and test. Courtesy of F. Collet.

Measurement of Water Vapor Permeability of Hemp concrete at LGCGM / Université de Rennes 1 (France): cup assembly and test. Courtesy of F. Collet.

Significance

The preservation of the environment is one of the principal features of sustainable development. Bio-based building materials has proven to have both viability and marketability in the construction industry, despite its 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.

Relevance

Testing and characterization procedures establishment will allow a wide and secure diffusion of these materials on the market. Circulation of TC outcomes will contribute to the network development among professionals as architects, craftsmen, owners and contractors in the construction field.

Goals

• Organizing a round robin test (RRT) about Hygrothermal properties on vegetal concrete specimen between 2019 and 2020.
• Drafting of recommendation to measure Moisture Buffering Value (MBV) and Water Vapour Permeability (WVP) of vegetal concrete.
• Production of a technical report and presentation of the main outputs at the fourth ICBBM, Barcelona 2021.

Methodology

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

Progress

• 16 meetings between 2017 and 2020.
• Round Robin Test (RRT) on hygrothermal properties began early 2019 and is ongoing: 10 labs working on thermal conductivity, 7 labs on moisture buffer value and 5 labs on water vapour permeability.
• RRT on durability is planned to start in late 2020.
• RRT will be concluded by a conference and publication of the results in 2021.

Digital fabrication with cement-based materials

276-DFC

Chair **Nicolas ROUSSEL**
Deputy Chair **Dirk LOWKE**
Activity started in 2016

Speakers of the international workshop "Digital Fabrication with Concrete", January 2020, Berlin-Germany. Courtesy of DBV, Berlin.

3D printed concrete bridge in Gemert, Holland. Courtesy of Marczoutendijk.

Significance

Digital fabrication translates 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 and laboratories around the world developing 3D printing techniques is progressively being created within RILEM.

Relevance

- 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 allow for increased productivity and structural morphologies that promotes material savings.

Goals

- Gathering information on materials and rheological properties, processes such as extrusion techniques, particle bed techniques, advanced slip forming and other patented technologies.
- Creating a database of examples of applications and cases studies along with a process classification.
- Producing a State-of-the-art report on this emerging field.

Methodology

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

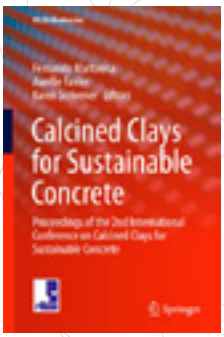
Progress

- STAR publication planned for Fall 2020.
- 2nd International RILEM Conf. Rheology and Processing of Construction Materials & 9th International RILEM Conf. on SCC (Sept 2019. Dresden).
- Workshop on Digital Fabrication with Concrete (Jan 2020, Berlin).
- 2nd RILEM International Conference on Concrete and Digital Fabrication (July 2020, Eindhoven, online event).

282-CCL Calcined clays as supplementary cementitious materials

Chair **José Fernando MARTIRENA-HERNANDEZ**
Deputy Chair **Manu SANTHANAM**
Activity started in 2018

Group photo of 3rd Int Conf on calcined clays for sustainable concrete. Courtesy of F. Martirena.



Proceedings of 2nd Int Conf on calcined clays for sustainable concrete. Courtesy of Springer.

Significance

The scarcity of common Supplementary Cementitious Materials (SCMs) like fly ash and slag and the great pressure that the cement industry is receiving on reducing GHG emissions, has prompted the use of calcined clays as an alternative to traditional SCMs. However, practical implementation demands for further information for companies and government bodies to adapt existing standards to the new product and tackle the yet remaining gaps in the knowledge.

Relevance

- The work of this TC will create the technical basis for a greener cement production by incorporating a new and abundant material 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 and share information on recent developments relevant to all areas of knowledge related to calcined clays, from the identification and characterization of raw materials to the manufacture and use of end products.
- 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 and industrial communities.

Methodology

- Investigation of the use of kaolinitic clays for the production of reactive pozzolans through their thermal activation and their use in cement manufacture.
- Analysis of clay mineralogy; parameters for calcination and grinding; hydration mechanisms in Portland-calcined clay and Portland calcined clay-limestone systems; durability of products made with calcined clay.

Progress

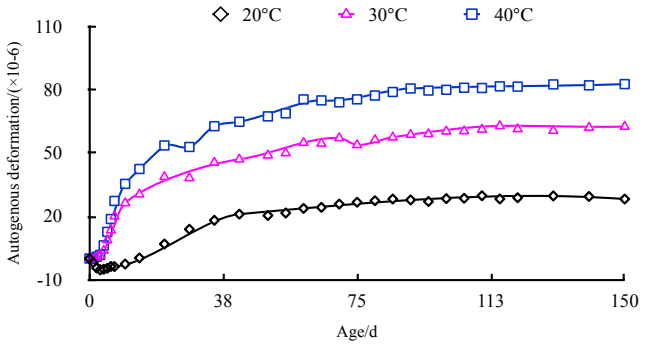
- 3rd International Conference on Calcined Clays for Sustainable Concrete (2019) New Delhi, India.
- First draft of paper "Guidelines for Geological Survey and Quality Appraisal of Kaolinitic Clays as Source of Supplementary Cementitious Materials" finalised and to be presented at next TC meeting in August 2020.
- First draft of paper "Fresh properties of concrete made with calcined clays" finalised and to be presented at next TC meeting in August 2020.

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

284-CEC

Chair **Jiaping LIU**
Deputy Chair **Ole Mejlhede JENSEN**
Activity started in 2018

Ole Mejlhede Jensen presents a small experiment on volume change and cracking at the doctoral course in Nanjing, China, in August 2019. Courtesy of O. Jensen.



Effect of curing temperature on autogenous deformation of concrete with 5% 100s-MgO expansive agent. Courtesy of Y. Wang.

Significance

MgO-based expansive agents have proven to be effective in compensating shrinkage and mitigating cracking of concrete. 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.

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, for producers of expansive agents to improve the quality of their products.

Goals

- Reaching a better understanding of the expansion of concrete after addition of MgO-based expansive agents.
- Giving guidelines for practical applications of MgO-based expansive agent, including publication of State-ot-the-Art report.
- Reducing the risk of crack formation by well-designed and controlled concrete expansion.

Methodology

- Carrying out the round-robin test series in at least five laboratories.
- Developing a prediction model for the expansion of concrete with MgO.

Progress

- Two TC meetings held so far.
- A RILEM EAC doctoral course 'Expansive Agents and Temperature Rise Inhibitor' which covered properties of MgO-based expansive agent was given during the 73rd RILEM Annual Week in Nanjing, China.

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

Dr Olonade presenting «Bio-based binder and cement replacement options» at the seminar in Dar es Salaam. Courtesy of D. Ciancio.

Cassava peel ashes are amongst the agro-based materials used as cementitious additions. Courtesy of HarvestPlus.

Significance

Agro-based materials are renewable materials that can reduce the construction industry greenhouse emissions and negative impact on the environment. However, there is currently a shortage of industrial applications.

Relevance

The target users of the outcomes of this TC are academics, practitioners, general public, Ph.D. students, end-users and contractors, governmental institutions and materials suppliers.

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.

Progress

- The kick-off meeting was held in Nairobi, Kenya, on 31 January-1 February 2019.
- A videoconference was held on April 18th, 2019.
- A meeting of the chairs with some members was held at the African MRS conference, December 2019, Arusha, Tanzania.
- The East African student seminar on “Materials technologies for sustainable construction” has been organised in February 2020 in Dar es Salaam, Tanzania.

Cluster B
Transport and Deterioration Mechanisms

Foreword
- from Cluster B Convener,
  Esperanza MENENDEZ MENDEZ

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 microorganisms. These technical committees are related mainly to cement based materials, pastes, mortars and concretes.

Between 2005 and 2019, 22 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.

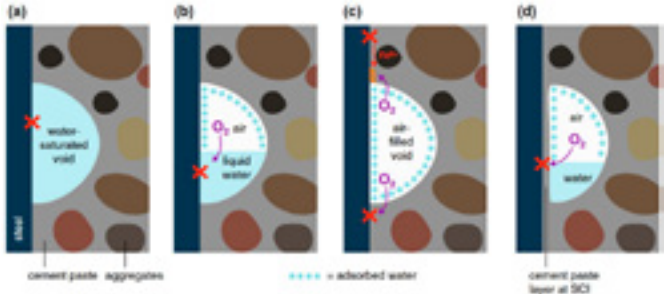
Current TCs in Cluster B

Code	Title	Chair	Deputy Chair	TC opened in
262-SCI	Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion	Ueli ANGST	Mette GEIKER	2015
281-CCC	Carbonation of concrete with supplementary cementitious materials	Nele DE BELIE	Susan BERNAL-LOPEZ	2018
283-CAM	Chloride transport in alkali-activated materials	Arnaud CASTEL	John PROVIS	2018
285-TMS	Test method for concrete durability under combined role of sulphate and chloride ions	Changwen MIAO	Geert DE SCHUTTER	2018
DOC	Degradation of organic coating materials and its relation to concrete durability	Takafumi NOGUCHI	Kei-Ichi IMAMOTO	2020 **NEW!**
FTC	Durability and Service Life of concrete under the Influence of freeze-thaw cycles combined with chloride penetration	Folker H. WITTMAN	Peng ZHANG	2018
GDP	Test methods for gas diffusion in porous media	Bruno HUET	Philippe TURCRY	2019

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

262-SCI

Chair Prof. **Ueli ANGST**
Deputy Chair **Mette GEIKER**
Activity started in 2015



Schematic sketches illustrating possible roles of macroscopic interfacial concrete voids (MICV) in corrosion initiation. *Materials and Structures* (2019) 52:88.

Corroded rebars. Courtesy of freeimageslive.co.uk.

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.

Relevance

- The targeted group of users is primarily researchers. This is because the findings of the TC firstly promote scientific discussion in the field of corrosion of steel in concrete.
- On the long term, however, 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.
- Summarizing existing methods to determine the conditions at the steel/concrete interface.

Methodology

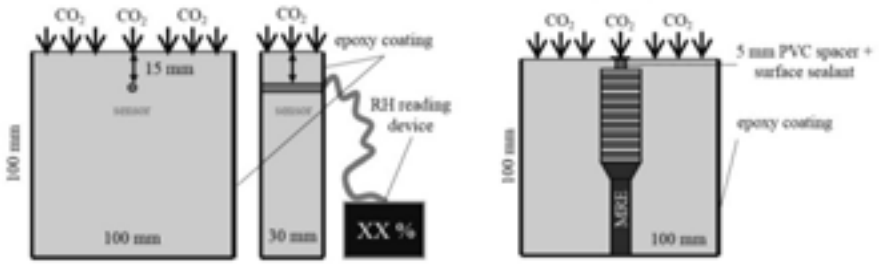
- In addition to bibliographical research, the committee work consists in exchange of experience and results, including unpublished results.

Progress

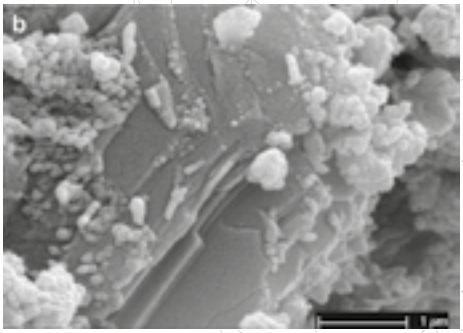
- Between June 2015 and March 2020, in total 14 TC meetings were held and two publications were prepared:
  - Angst U. et al. (2017) The steel-concrete interface. Mater Struct 50:143.
  - Angst U. et al. (2019) The effect of the steel-concrete interface on chloride-induced corrosion initiation in concrete: a critical review by RILEM TC 262-SCI, Mater Struct 52:88.
- These two publications offer a systematic analysis of characteristics that may be present at the SCI as well as their influence on corrosion initiation. Some of these findings may be unexpected, as parameters so far largely ignored appear to play a major role.
- The TC work gives important guidance for future research in corrosion of steel in concrete.

281-CCC Carbonation of concrete with supplementary cementitious materials

Chair **Nele DE BELIE**
Deputy Chair **Susan BERNAL-LOPEZ**
Activity started in 2017



Setup of Humidity (a) and resistivity (b) experiments, *RILEM PRO 128* (2019), Vol 3, p 317.



Formation of calcite on the basal faces of portlandite. *Materials and Structures (2012)* 47(16).

Significance

SCM-containing concrete exhibits high carbonation susceptibility. As carbonation is responsible for causing corrosion of embedded steel bars, a deeper understanding of chemical and transport phenomena in such concrete is needed. Furthermore, prediction models for carbonation-induced corrosion need to be adapted for concrete containing SCMs.

Relevance

- Carbonation of concrete with SCMs and alkali-activated concrete is an important consideration for practitioners.
- Targeted users of the outcomes of this TC are academics, testing laboratories, industrialists and practitioners.

Goals

- Assess the effects of carbonation on phase assemblage under accelerated and natural carbonation conditions for SCM containing 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 of SCM-containing concrete.
- Optimize models for carbonation-induced steel depassivation in blended and alkali-activated binder concrete to achieve a more accurate service life prediction.

Methodology

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

Progress

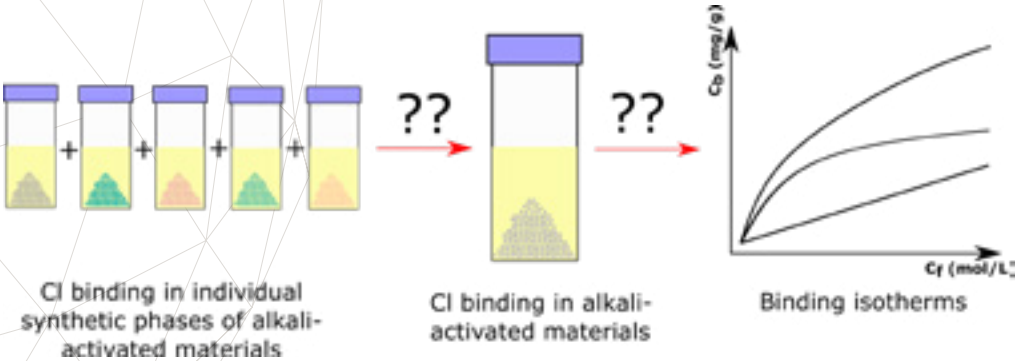
- Carbonation of concrete with supplementary cementitious materials, Special Session in the *International Conference on Sustainable Materials, Systems and Structures (SMSS2019),* Rovinj, Croatia, RILEM PRO 128 (18 papers).
- State-of-the-art paper "Understanding carbonation of Concrete with Supplementary Cementitious Materials – A Review" is nearly ready for submission to *Materials and Structures.*
- Special session during the 74th RILEM Annual Week, August 2020, Sheffield (UK) (14 abstracts submitted).

Chloride transport in alkali-activated materials

283-CAM

Chair **Arnaud CASTEL**
Deputy Chair J**ohn PROVIS**
Activity started in 2018

Portland specimens. Courtesy of D. Law, RMIT.



Assessing chloride binding in AAMs. Courtesy of S. Mundra, BAM.

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.

Relevance

Outcomes will be of beneficial for researchers who are interested in understanding chloride-related durability of AAMs and industrial end-users who are seeking to specify AAMs.

Goals

- Reducing Barriers for Commercial Adaptation of AAMs through the development of performance-based specifications.
- Adapting/recalibrating existing testing methods (ASTM C1556, ASTM C1202, NT BUILD 492) to be used to assess AAMs performance in chloride environments.
- Developing a better understanding of chloride binding (ion-exchange, physical adsorption) within AAMs.
- Developing predictive chloride diffusion models for AAMs and validation using laboratory or in-service data.

Methodology

- Working group 1: Performance based specifications for AAMs.
- Working group 2: Chloride binding capacity of AAMs and chloride diffusion modelling.
- Comparison between laboratory results and simulations to data obtained from analysis of samples placed in the field under service conditions.

Progress

- Kick-off meeting held at Polytech Nice Sophia Antipolis (France) in 2018.
- Last TC meeting held at ICCC congress in Prague in September 2019: technical activities within each WG have been planned, including experimental investigations and modelling.
- First field specimens were collected in Portland, VIC Australia after about two years of exposure in tidal zone.
- Laboratory experiments assessing chloride binding in synthetic phases such as Mg-Al-(OH, CO3)-LDH phases, AFm phases, and various GGBS based AAMs are ongoing at BAM, Germany.
- An experimental protocol to assess free and bound chloride within these materials is currently being established.

285-TMS

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

Chair **Miao CHANGWEN**
Deputy Chair **Geert DE SCHUTTER**
Activity started in 2018

Spalling of concrete column in salty soil. Courtesy of Mu Song.

Room Test for reinforced concrete durability under combined role of sulphate and chloride. Courtesy of Mu Song.

Significance

• Deterioration processes of combined sulphate and chloride attack are rather complex for reinforced concrete.
• Under the combined role of sulphate and chloride ions, service life of reinforced concrete structures can be shortened considerably.

Relevance

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

Goals

• To develop a standardized test method.
• To quantify the influence of environmental factors on the corrosion of steel bars and deterioration of concrete. In addition, mechanical load may be considered when enough support is available from TC experts.
• 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

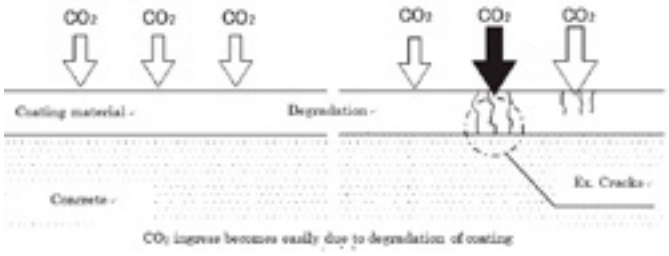
• Ongoing drafting of the state of the art report on test methods of sulphate attack and chloride transport.
• Ongoing developing of a standardized test method to determine service life of concrete structures under the combination of sulphate and chloride ions or the combination of mechanical load and the coupling ions.
• Upcoming TC working meeting was planned to be held in conjunction with 4th International RILEM Conference on Microstructure Related Durability of Cementitious Composites, Den Haag, The Netherlands, but the exact date is not determined yet due to the unexpected coronavirus epidemic.

Degradation of organic coating materials and its relation to concrete durability

DOC

Chair **Takafumi NOGUCHI**
Deputy Chair **Kei-Ichi IMAMOTO**
Activity started in 2020

Coating the walls of buildings.
Courtesy of Japan Building Coating Materials Association.



Schematic description of ingress of harmful component through coating material. Courtesy of K. Imamoto.

Significance

• Coating materials contributes to extend the lifetime of concrete structures by acting not only as texture of a building but also as protection of reinforced concrete structures from harmful substances.
• Organic coating material such as multi-layer coating material will degrade by ultraviolet light and/or heat and its barrier effect might be reduced.
• The effect of coating materials to prevent the ingress of CO2 have been extensively verified throughout accelerated tests in laboratory conditions. However, the degradation of coating materials under real environmental conditions and its relation to concrete durability still need further investigation.

Relevance

• Academics, testing laboratory workers, industrialists, practitioners and designers.

Goals

• The target of this TC is not to just develop durable coating agent but to evaluate the impact of deterioration of coating materials on durability of concrete.
• This RILEM Technical Committee will conduct scholarly activities towards developing deeper fundamental understandings of the mechanisms of degradation of coating materials and its relation to concrete durability under real environmental condition.

Methodology

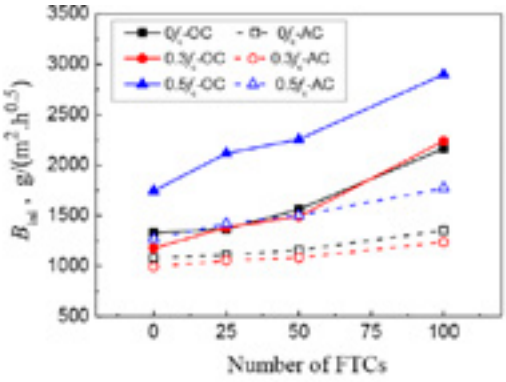
• The work will include literature research, exchange of good practices information, journal publications and/or state-of-the-art report.
• A small session will be planned at the “International Symposium on durability of building materials and components-DBMC” held in Barcelona in 2020.
• The “International symposium on regeneration and conservation of structures - RCS” will be organised during RILEM Annual Week in Kyoto in 2022.

Progress

RILEM TC DOC has been approved by the RILEM board in spring 2020.

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



Coefficient of capillary absorption of ordinary concrete (OC) and aerated concrete (AC) as function of the imposed number of freeze-thaw cycles under an applied compressive load of 0, 0.3, and 0.5 of the compressive strength. Courtesy of F.H. Wittmann.

Concrete piers in sea water subject to freezing process. Courtesy of DMCA.

Significance

• So far, the influence of environmental actions and mechanical load is considered separately in practice and by standards. Consequently, the predicted service life of reinforced concrete structures is often not reached.
• As an example, in recent years a number of wide span bridges collapsed long before the designed service life was reached and other structures needed extensive repair measures at an early age.

Relevance

• Safe and long lasting reinforced concrete structures can be built only on the basis of more realistic prediction models and standards.

Goals

• More realistic service life prediction is obviously needed. This aim can be reached only by close cooperation and interaction of a number of active RILEM TCs. FTC is one TC only in a group of TCs with similar aims.

Methodology

• Comparative test series shall be run in a number of laboratories in different countries. Results shall be compared and critically discussed.

Progress

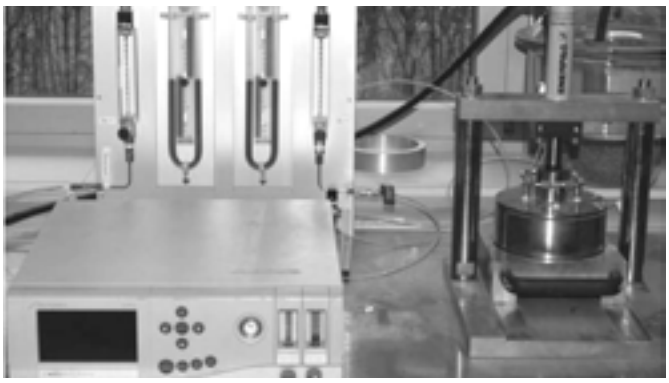
• A comprehensive literature review was established by now and will be published soon. A number of comparative test series was prepared in different laboratories. Due to the Corona epidemic, however, tests could not be run as planned. Work of this TC is seriously retarded due to this unforeseen event.
• As an example the capillary water absorption of ordinary concrete and of aerated light weight concrete was determined and is shown in the Figure above. The characteristic difference of water absorption of different types of concrete under load can be seen.

Test methods for gas diffusion in porous media

GDP

Chair **Bruno HUET**
Deputy Chair **Philippe TURCRY**
Activity started in 2019

Diffusion cell in RH chamber. Courtesy of LafargeHolcim.



Gas diffusion cell. Courtesy of EMPA – Switzerland.

Significance

Rebar corrosion and other detrimental phenomena for concrete are linked to oxygen, carbon dioxide and water vapour mass transfer. The gas diffusion coefficient is a general indicator of the resistance to gas transfer. Different methods for measuring gas diffusion coefficient of cementitious materials have been developed but no technical consensus exists on those methods.

Relevance

- The results of this TC will be useful for the definition of future standards. In particular, they will be of interest to technical bodies of the European committee for standardisation (CEN).
- Published documentation could also serve a reference technical documentation for laboratories (academics, industries, service companies).

Goals

- 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 with existing test methods.
- Harmonized test methods including analytical calculation to assess gas diffusion from raw experimental measurements and source of uncertainties.

Methodology

- Collecting information on existing gas diffusion tests and state of the art review.
- Proposal of a benchmark of methods on reference inert materials and non-ageing cementitious materials is proposed.
- Assessing the effect of low pressure difference gradient for each test method, resulting from the setup or multi-species diffusion.

Progress

- The writing of the state of the art report is on-going.
- The inter-labs campaign has started with the making of cementitious materials specimens for each partner.
- First results will be presented at the 74th RILEM Annual Week in August 2020.
- An international Workshop on gas diffusion and gas permeability in porous building materials is planned by late 2021.
- New contributions for alternative reference materials and testing methods are still welcome to the TC!

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". A close collaboration with *fib* and their impressive work on drafting the *fib*-model code 2020 is also materialised through the cluster.
Currently, in the Cluster seven TCs are active in impact and explosion (IEC), damage assessment in consideration of repair-retrofit-recovery (269-IAM), fire spalling (256-SPF), structural behaviour of recycled aggregate concrete (273-RAC), crack width analysis (CCS), textile reinforced concrete (MCC) and alkali-activated concrete (MPA).
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.

Current TCs in Cluster C

Code	Title	TC Chair	TC Deputy Chair	TC opened in
256-SPF	Spalling of concrete due to fire: testing and modelling	Pierre PIMIENTA	Robert JANSSON MC NAMEE	2013
269-IAM	Damage assessment in consideration of repair/ retrofit-recovery in concrete and masonry structures by means of innovative NDT	Tomoki SHIOTANI	Dimitrios AGGELIS	2016
273-RAC	Structural behaviour and innovation of recycled aggregate concrete	Jianzhuang XIAO	Yamei ZHANG	2015
CCS	Early age and long-term crack width analysis in RC structures	Miguel Ângelo Dias AZENHA	Fragkoulis KANAVARIS	2019 **NEW!**
IEC	Impact and explosion	Marco DI PRISCO	Ezio CADONI	2018
MCC	Mechanical characterization and structural design of textile reinforced concrete	Barzin MOBASHER	Flávio DE ANDRADE SILVA	2019 **NEW!**
MPA	Mechanical properties of alkali-activated concrete	Guang YE	Frank DEHN	2019 **NEW!**

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

Chair **Pierre PIMIENTA**
Deputy Chair **Robert JANSSON MC NAMEE**
Activity started in 2013

Members of the Technical Committee 256-SPF at the 12th TC meeting in September 2019 in Sheffield, UK. Courtesy of Shan-Shan Huang.

Concrete spalling during a fire test. Courtesy of I. Burgess.

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.

Methodology

The TC has 52 active members and is organised in 4 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.

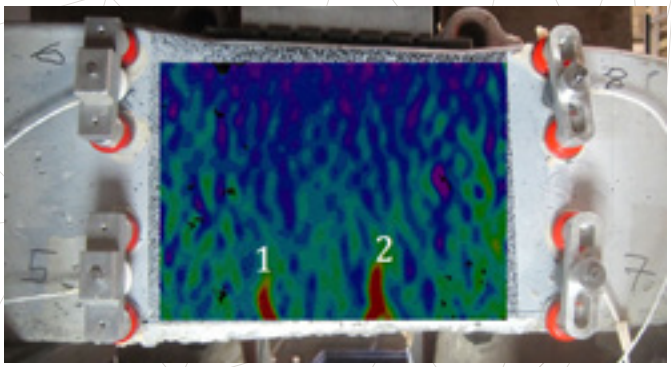
Progress

- 6th "International Workshop" on September 19-20, 2019, organized by Sheffield University (Dr Shan-Shan Huang) and the RILEM TC as Scientific Committee.
- STAR in preparation on concrete spalling under fire.
- Recommendations in preparation on screening and full-scale spalling tests methods.
- Several published papers based on Task 2: Influence on fire resistance and residual capacity and Task 4: Modelling of spalling phenomenon.

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

269-IAM

Chair **Tomoki SHIOTANI**
Deputy Chair **Dimitrios AGGELIS**
Activity started in 2016



Combined use of Digital Image Correlation and AE source localization for crack detection and characterization. Courtesy of MEMC-VUB.

TC members in Turin, Italy, at the 7th meeting. Courtesy of Tomoki Shiotani.

Significance

Worldwide infrastructure is aging. Proper condition evaluation and maintenance are essential. There is an urgent necessity to change maintenance from "reactive" to "proactive" as the latter requires less budget.

Relevance

- Targeted users are construction and maintenance industries, owners/managers of infrastructure, a broad range of stakeholders.
- Better use of resources and increased safety and reliability will benefit society.

Goals

- Exploring effective NDT techniques to use in structures.
- Quantifying the repair effect.
- Improving reliability of repair and monitoring methods.
- Establishing life cycle scenarios considering repair improvement as obtained by NDT techniques.
- Publishing RILEM recommendations and recommended practices for quantification of repair/ reinforcement works by NDT; workshop proceedings, possibly as a special issue of Materials & Structures, State-of-the-Art Report (STAR).
- Organising training courses for one-site measurement by NDT.
- Submitting pre-standards to ISO.

Methodology

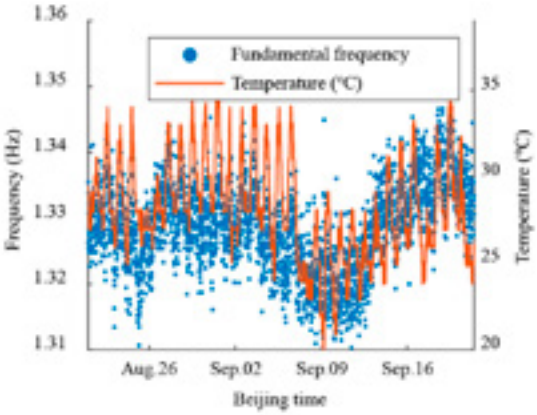
- Studies of repair practices in different countries.
- Organization of "task forces" focused on:
  1. Survey (suitable NDT methods).
  2. Evaluation of initial damage.
  3. Evaluation of repair.
  4. Life cycle management in relation to 3.

Progress

- Seven meetings have taken place so far.
- Preliminary discussion on the assignment of task force topics has taken place in the last meeting.
- Discussion about distribution of chapters of STAR to TC members will be done in the next months.

273-RAC Structural behaviour and innovation of recycled aggregate concrete

Chair **Jianzhuang XIAO**
Deputy Chair **Yamei ZHANG**
Activity started in 2015



A unique 12-storey twin-tower project in Shanghai, China, consisting of a structure made with RAC (Tower A) and a structure made with NAC (Tower B) is used to demonstrate the comparative carbon footprint implications of RAC and NAC. On the right, it shows the relation between the fundamental frequency and the temperature over time. Courtesy of J. Xiao.

Significance

The properties of Recycled concrete aggregate (RCA) should be improved to efficiently facilitate the effective reuse of RCA, especially in structural components. The reuse of 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 and recycling of materials for structural use.

Goals

- To predict and improve the mechanical properties of recycled structural concrete.
- To encourage the transfer of TC's findings to practitioners.

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 behavior and long-term properties of RAC.
- Analyzing the existing standards and specifications of RA and RAC.

Progress

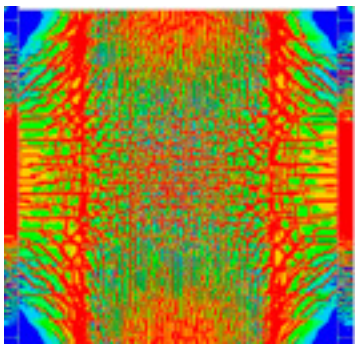
- TC 273-RAC, Part A - Report on Recycled Aggregate Concrete Material Properties is ready to be published.
- TC 273-RAC, Part B - Report on Recycled Aggregate Concrete Structural performance, is still under the compilation phase.
- 2020, Shanghai (CN): A meeting was scheduled in April 2020 in Shanghai during the *fib* symposium, but due to an epidemic situation because of COVID-19, the meeting will be rescheduled to November 2020. In this meeting, the final draft of Part B - Report on Recycled Aggregate Concrete Structural performance is to be discussed.

Early age and long-term crack width analysis in RC structures

CCS

Chair **Miguel AZENHA**
Deputy Chair **Fragkoulis KANAVARIS**
Activity started in 2019

Leakage from cracks in a concrete tunnel.
Courtesy of F. Kanavaris.



Simulated cracking pattern in reinforced concrete slab.
Courtesy of José Paulo Fonseca Ferreira.

Significance

• Cracking due to restrained shrinkage and thermal effects is still an ongoing serviceability issue in concrete structures.
• Understanding and improving current approaches require a strong element of interdisciplinarity, focusing on the interplay between materials science and structural engineering.
• This entails the need to adequately combine the fundamental material behaviour of concrete since casting with experimental substantiation and advanced numerical and analytical modelling of cracking in structures.

Relevance

• Academics working with fundamental materials properties and numerical simulation of materials properties, testing laboratories, industrialists working with e.g. materials development, scientists within engineering practice, structural designers, analysts, contractors and consultants.
• Owners and designers of buildings, liquid retaining structures, iconic structures, nuclear containments and other safety critical structures.

Goals

• Organise a dedicated international RILEM conference.
• Publish RILEM Recommendations on thermo-mechanical analysis of concrete.
• Publish a RILEM/Springer book on "Interdisciplinary approach to early age and long-term crack width analysis in RC Structures: from material science to structural design".
• Establish leading edge guidance which will promote a more accurate and sustainable approach to control of cracking in reinforced concrete structures.

Methodology

• Use of web platforms of conference calls to perform on-line meetings (roughly half of the meetings).
• Benchmarking of numerical and analytical models for crack width estimation.
• Bibliographical research and exchange of experience and results, including unpublished results.

Progress

• 2 videoconferencing meetings held since November 2019.
• RILEM Recommendations on thermo-mechanical modelling of concrete is being prepared.
• Near-final draft outline of a RILEM book on crack width analysis has been prepared.
• RILEM conference on concrete cracking is planned as part of the RILEM 2021 Spring Convention in Paris.

IEC Impact and explosion

Chair **Marco DI PRISCO**
Deputy Chair **Ezio CADONI**
Activity started in 2018

Shock tube at the laboratory of «Polo Territoriale di Lecco», Italy.
Courtesy of M. Di Prisco.

Participants of the online IEC meeting on May 4, 2020.
Courtesy of M. Di Prisco.

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.
• 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.

Methodology

• The first database has been completed; the working group met in the occasion of the last RILEM/*fib*/ACI Workshop Protect 2019 in Vancouver and this year is working on the *fib* background document and the chapter 27 of the Model Code 2020.
• In the two following years, the Committee will achieve the last three main objectives.

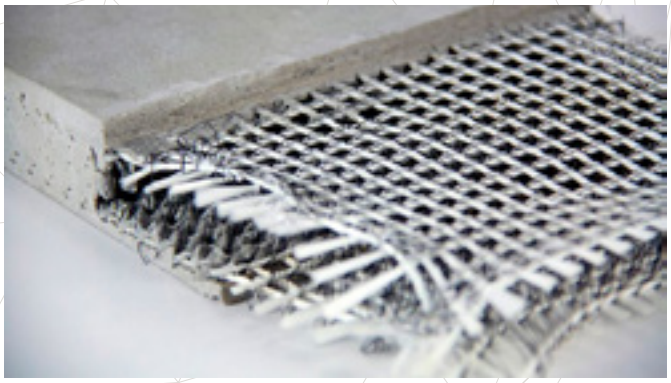
Progress

• Seven meetings held so far.
• Collection of data from 10 labs with the references of the work published to allow RILEM community to use them without replicate them everywhere: finalized.
• *fib* bulletin as framework reference of the Model Code 2020 - Some chapters drafts are ready.

Mechanical characterization and structural design of textile reinforced concrete

MCC

Chair **Barzin MOBASHER**
Deputy Chair **Flávio DE ANDRADE SILVA**
Activity started in 2019



Textile reinforced concrete sample. Courtesy of R. Thyroff.

TRC bridge in Albstadt-Ebingen. Courtesy of Solidian.

Significance

• Textile reinforced concrete (TRC) materials are lightweight, ductile, strong, and have the potential to be used as structural components taking tensile, flexural, cyclic and impact loads.
• The advancements in the textile technology specifically directed at their use in cement based materials has led to composites with an order of magnitude higher in strength and two orders of magnitude higher in ductility than fiber reinforced concrete (FRC). This also provides an excellent opportunity as repair materials.
• TC MCC is a follow-up to TC 201-TRC and TC 232-TDT: Test methods and design of textile reinforced concrete.
• This TC is linked with current efforts in areas of: ultra-high performance concrete materials, UHPC, 3D printing, FRCM and repair of infrastructure, as well as the C3 Consortium addressing carbon Cement Composites. The common areas are in urgent need to develop and implement design tools and applications for strain hardening cement composites.

Relevance

Testing laboratories, owners of infrastructure addressing repair and retrofit applications, Sustainable construction systems development, Construction companies, research centers and Universities.

Goals

• The proposed TC continues to develop recommendations of test methods and work out procedures for application development and design of composites.
• At the beginning, the State-of-the-Art document will be developed to address the recent developments in the past 15 years as a follow up to the work of previous committees.
• The expected outcomes include the develop a set of recommendations and design guides.
• This TC plans to organise training courses for graduate students and researchers in the TRC area, followed by the Summer courses offered at Milan Politecnico di Milano in 2013 and 2019, and Technical University of Dresden in 2015 and 2019.
• Collaborations and Publication of standards and reports with ASTM, *fib*, and ACI as well as ISO.

Methodology

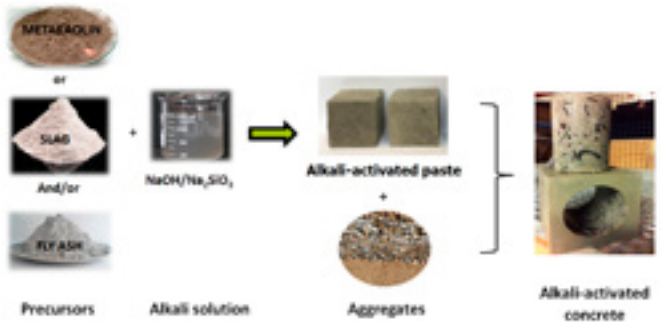
• Five working groups are currently in place:
WG1–Materials and material systems
WG 2 – Constitutive modelling
WG 3 – New Elements
WG 4 – Retrofitting
WG 5 – Durability and sustainability
• Close working relations with ACI Committee 549 on thin sections and ACI 544-Fiber Reinforced Concrete, C3, and *fib* are essential as the members of these committees will also be serving on the proposed TC.

Progress

RILEM TC MCC has been approved by TAC in August 2019.

MPA Mechanical properties of alkali-activated materials

Chair **Guang YE**
Deputy Chair **Frank DEHN**
Activity started in 2019



Scheme of AAM. Courtesy of G. Ye.


Notched sample of AAM. Courtesy of TC MPA.

Significance

Alkali-activated concrete is considered as an environment-friendly construction material with a great potential for construction. However, at this moment it is not fully clear whether existing design codes for structural concrete can be fully applied in case of alkali-activated concrete. Although short term behaviour (28 days) might be similar, this might not be the case for the long-term behaviour and simply applying existing codes for conventional concrete to design alkali-activated concrete structures could be problematic. Another key point of focus is creep and shrinkage of alkali-activated concrete as the application of traditional creep and shrinkage laws has not still been defined suitable.

Relevance

- Academics working with fundamental materials behaviour and numerical simulation of materials properties.
- Testing laboratories.
- Industrialists working with e.g. materials development.
- Structural designers and contractors.

Goals

- To gather available information related to the mechanical properties and mechanical behaviour of alkali-activated concrete.
- To evaluate whether the existing design codes for structural concrete can be fully applied in case of alkali-activated concrete.
- The results of TC MPA will contribute to a more precise design of concrete and concrete structures made of alkali-activated concrete.

Methodology

The TC MPA will last for 4 years and its work consists:

- Forming a TC committee with worldwide experts.
- Establishing of consensus on strategy and limitation of work.
- Collecting and discussing the published data, and identifying on-going projects related to mechanical properties of alkali-activated concrete.
- Forming working groups of different topics on mechanical properties of alkali-activated materials.
- Performing round robin tests on selected mechanical properties of alkali-activated concrete.
- Writing the state-of-the-art-report on mechanical properties of alkali-activated concrete.
- Promoting the TC results by organizing a symposium or workshops.

Progress

- 51 TC members registered so far; online kick off meeting of TC MPA held on 11 March 2020.

Cluster D
Service Life and Environmental Impact Assessment

Foreword
- from Cluster D 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 four TCs. The topics covered by these TCs vary from alkali-silica reactions to chloride ingress, stress corrosion cracking and durability in marine exposure conditions. 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.

Current TCs in Cluster D

Code	Title	TC Chair	TC Deputy Chair	TC opened in
258-AAA	Avoiding alkali aggregate reactions in concrete - performance based concept	Børge J. WIGUM	Jan LINDGARD	2014
270-CIM	Benchmarking chloride ingress models on real-life case studies: theory and practice	Eddie A. B. KOENDERS	Kei-ichi IMAMOTO	2016
CCH	Stress corrosion cracking and hydrogen embrittlement of concrete-reinforcing steels	Javier SANCHEZ MONTERO	Alvaro RIDRUEJO	2016
DCM	Long-term durability of structural concretes in marine exposure conditions	Kefei LI	Junjie ZENG	2019

Avoiding alkali aggregate reactions in concrete - performance based concept

258-AAA

Chair **Børge WIGUM**
Deputy Chair **Jan LINDGÅRD**
Activity started in 2014

Accelerated concrete prism testing at 60oC – RILEM-AAR-11. Courtesy of B. J. Wigum.

Measuring map-cracking of AAR in field. Courtesy of B. J. Wigum.

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.

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

• TC 258-AAA terminated its activities during the final meeting in Delft, the Nederland's, in December 2019.
• The TC is in the progress of completing recommendations and a comprehensive "State-of-the-art" Report.
• The work has been presented at several conferences in 2018 and 2019 (information included in last year RILEM Technical Report).

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

Chair **Eddie KOENDERS**
Deputy Chair **Kei-Ichi IMAMOTO**
Activity started in 2016

Marine submerged case. Courtesy of T. Luping.

Road spray case. Courtesy of © Schweizerische Gesellschaft für Korrosionsschutz (SGK).

Significance

Analytical and numerical models can be employed for simulating the ingress of chlorides into the concrete cover but a benchmark serves as a reference tool for calibrating current and future generations of chloride ingress models.

Relevance

- A calibration tool for chloride ingress models enables engineers/consultants to assess durability of concrete structures more accurate and reliable.
- Enhancing the prediction accuracy of chloride ingress models will support the entire chain of users, i.e. academia, consultancy, industry, governmental bodies, etc..
- A significant economic impact will be on the accuracy and reliability of durability predictions and future maintenance needs of concrete structures.

Goals

- Benchmarking various analytical and numerical models on a typical marine submerged and road spray case.
- Defining a calibration method for analytical and numerical models based on the benchmark results.
- Writing a STAR report, and RILEM recommendations for practitioners.

Methodology

- Identifying and selecting currently available analytical and numerical models used for chloride ingress calculations.
- Selecting and defining two typical case studies to be employed for benchmarking.
- Simulating the chloride ingress for the two case studies with the selected analytical and numerical models, and analyse the performance.
- Identify potential gaps in model accuracies, differences, coverages and model limitations.

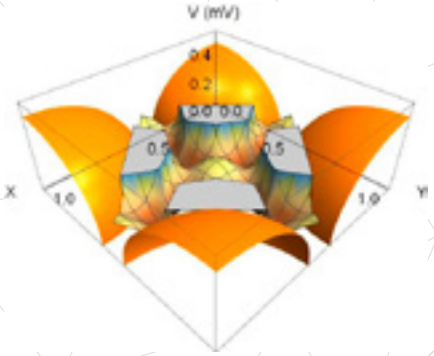
Progress

- Benchmarking case studies on marine submerged and road spray cases are conduced and results have been analysed. A calibration procedure is under development.
- Chapter structure for the STAR report is defined and chapters are being drafted.
- Publication of the STAR and RILEM recommendations is planned for 2022.
- Koenders E.A.B. (2018) Modelling of chloride ingress in concrete based on benchmarking field results, *MATEC Web of Conferences,* 199, 01005 (open access).

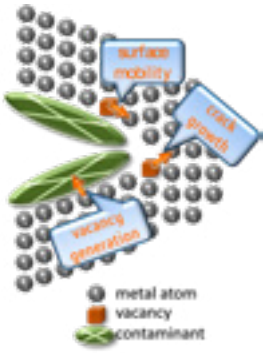
Stress corrosion cracking and hydrogen embrittlement of concrete-reinforcing steel

CCH

Chair **Javier SANCHEZ MONTERO**
Deputy Chair **Alvaro RIDRUEJO**
Activity started in 2016



Potential field for hydrogen in bcc iron lattice.
Courtesy of A. Ridruejo and J. Sanchez.



Schematics of crack growth by surface mobility mechanism.
Courtesy of J. Sanchez.

Significance

- Corrosion is the main cause of structure degradation. Prestressed steel 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 condition assessment of structures under aggressive environments.

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 frame to estimate 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.
- During the last year, we met in Rovinj (Croatia) during the RILEM Spring Convention and in Sevilla (Spain) during EUROCORR meeting.
- We are preparing a TC meeting within 74th RILEM Annual Week & 40th Cement and Concrete Science Conference in Sheffield (UK), 31 August - 4 September 2020.

DCM

Long-term durability of structural concretes in marine exposure conditions

Chair **Kefei LI**
Deputy Chair **Junjie ZENG**
Activity started in 2019

Visit of Punta Matamoros exposure site, June 2019, Cuba. Courtesy of. Kefei Li.

Group photo of kick-off meeting, June 2019, Cuba. Courtesy of Kefei Li.

Significance

• Data collection from exposure stations is rather intuitive, and a systematic format for data collection/presentation is missed. The standardized 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 practical indicators through advanced modelling.

Relevance

• The target users include academics, concrete and cement producers, and owners of exposure sites. Spin-off results can be formulated into educational courses for PhD students and professionals.

Goals

• Gathering long-term exposure data from in-field stations, under an agreed data-sharing policy set up within the group.
• Exploiting the long-term data using deepened models in collaboration with the exposure sites, with robin tests for the similitude study for exposure-exposure and exposure-laboratory.
• Producing general technical guidelines for exposure stations.

Methodology

• Establishment of long-term exposure database for natural marine environments and the correct presentation of exposure data.
• Exploitation of the long-term exposure data via mechanism interpretation and the rational indicators for engineering use.
• Application of long-term exposure/observation data and their exploitation to the service life design and management of concrete infrastructures.

Progress

• The paper "Long term exposure data of structural concretes in marine environment: presentation, interpretation and application" is under drafting and expected to be finished by August 2020 to be submitted to *Materials and Structures.*
• Kick-off meeting held at the International Symposium on Long-term Exposure and Observation of Structures on Ocean Engineering (LEOSOE'2019) in June 2019 in Cuba.
• An online meeting was held in May 2020 among the TC-Chair and three group leaders.
• The first TC-Meeting was scheduled in September in Europe. However the COVID-19 situation made this organization uncertain.

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 four TCs, working on earthen-materials (274-TCE), repair mortars (277-LHS), masonry reinforcement (IMC) and decay induced by salt crystallization in various substrates (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 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.

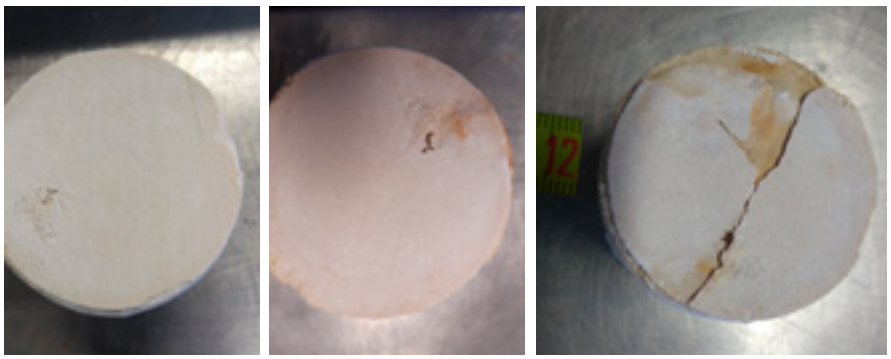
Current TCs in Cluster E

Code	Title	TC Chair	TC Deputy Chair	TC opened in
271-ASC	Accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization	Barbara LUBELLI	Inge RORIG-DALGAARD	2016
274-TCE	Testing and characterisation of earth-based building materials and elements	Jean-Claude MOREL	Antonin FABBRI	2016
277-LHS	Specifications for testing and evaluation of lime-based repair materials for historic structures	Ioanna PAPAYIANI	Jan VALEK	2017
IMC	Durability of inorganic matrix composites used for strengthening of masonry constructions	Antonietta AIELLO	Catherine PAPANICOLAOU	2019

Accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization

271-ASC

Chair **Barbara LUBELLI**
Deputy Chair **Inge RÖRIG-DALGAARD**
Activity started in 2016



Evolution of the damage in Migné specimens contaminated with sodium sulfate during the propagation phase: start (left), after 1 (middle) and 3 (right) rewetting cycles at 20°C. Courtesy of J. Desarnaud, BBRI.

Determination of liquid permeability by CT scanner at Gent University. Courtesy of H. Derluyn.

Significance

Salt crystallization is a major cause of damage in porous building materials. Existing (standard) crystallization tests are generally not realistically reproducing the transport and crystallisation process, resulting in unrealistic damage types. The development of an improved salt crystallization test procedure is needed.

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.
- 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.

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, *Mater and Struct* 51, 55.
- Flatt R. et al. (2017) Predicting salt damage in practice: a theoretical insight into laboratory tests, *RILEM Technical Letters,* 2: 108.
- Two papers on the first experimental and modelling results are in preparation.
- A draft test procedure is defined; round robin test is planned to start in 2020.
- The SWBSS2021 conference is planned on 22-24 September 2021 in Delft. In this occasion, the final results of this TC will be presented.

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

Chair **Jean-Claude MOREL**
Deputy Chair **Antonin FABBRI**
Activity started in 2016

An office building under construction in Lyon, France: unstabilised rammed earth load-bearing 3 storeys; architects: Clément Vergely; Masons: Nicolas Meunier, Structural engineers: Batiserf. Courtesy of Batiserf.

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.

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

• 8 meetings held so far.
• Chapters for the STAR are being collected and a draft of it has been discussed at the meeting held in Guimarães in March 2020.
• Round Robin tests are ongoing for compressive strength and hygrothermal properties.
• LCA is in progress.
• Durability will be addressed in the future.

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

277-LHS

Chair **Ioanna PAPAYIANNI**
Deputy Chair **Jan VALEK**
Activity started in 2017

Applying lime based mortars on site Galerius Palace Thessaloniki 4th century BC. Courtesy of M. Sarantidou, Architect.

Comparing test methods of measuring workability of lime based mortars. Courtesy of I. Papayianni.

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.

Relevance

- Industry is advantaged from upgrading the quality, reliability and performance of prefab materials for HS.
- Construction stakeholders will benefit from the quality of the repair works (in terms of economy, longevity and sustainability).

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.

Methodology

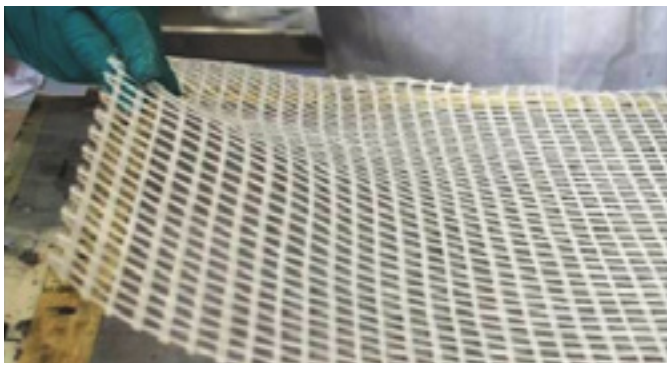
- Selection of all standards (EN, ISO, ASTM, etc) pertinent to testing quality of L-b-M.
- Review of suitability existing test methods in evaluating the performance of L-b-M.
- Propose adaptations/modifications to standard methods and field tests.

Progress

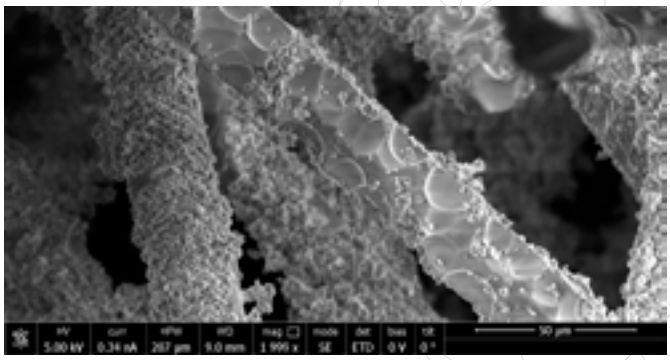
- Veiga R. et al. (2019) Durability of lime based renders: a review of some degradation mechanisms and assessment methods, Proceedings of RILEM SMSS Conv, Croatia.
- Groot C. et al. (2019) Durability aspects related to repointing of historic of historic mortars with lime based mortars, Proceedings of RILEM SMSS Conv, Croatia.
- Pachta V. et al. (2019) Evaluation of the fresh state properties of lime based grouts through inter laboratory comparative testing, 5th Historic Mortars Conference HMC2019, Spain.
- Papayianni I. and Hughes J.J. (2019) Testing properties governing the durability of lime-based mortars, *RILEM Technical Letters,* 2019.
- TC 277-LHS participation in the organization of HMC 2019, Pamplona, Spain.
- Preparatory work done for the organization of the 1st RILEM TC 277-LHS Workshop (www.rilemlhsworkshop.com) that has been postponed because of the current COVID-19 epidemic.
- Two State of the Art Reports ready for publication: 1) Mechanisms of Hydration and Hardening of L-b-M and 2) Admixtures/Additives in modern mortars/grouts.

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

Chair **Maria Antonietta AIELLO**
Deputy Chair **Catherine PAPANICOLAOU**
Activity started in 2016



Textile glass reinforcement embedded in an inorganic matrix. Courtesy of Structural Engineering team, University of Salento, Italy.



Scansion Electron Microscopy - E-glass fibers after alkaline attack. Courtesy of Structural Engineering team, University of Salento, Italy.

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. The study of the long-term behaviour, currently missing, is necessary in order to provide complete design guidelines for practitioners.

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 also benefit from the results of the IMC-TC.

Goals

- Narrowing the gap in knowledge that may limit the use of FRCM materials in structural strengthening of masonry buildings.
- Testing ageing procedures in laboratory environment.
- Providing 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).
- Analytical study to formulate relationships between the detrimental effects of temperature-accelerated tests and ageing protocols performed at 23°C.

Progress

- State of-the-Art report on “Strengthening of masonry structures with IMC: Durability Aspects and Structural implications” is under preparation; Chapter leaders and contributors have been appointed.
- An extensive test campaign addressing the durability of IMC constituent materials and components under alkali attack has been designed and will be circulated among the TC members for comments and suggestions. The finalized test plan will be carried out by numerous labs linked to the TC.

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), and from September 2020 onwards by Eshan V. Dave, U New Hampshire (US), engages approximately 150 experts from 25 countries, and is composed of 6 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 Journal 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, December 14th to 16th in Lyon (FR), also presenting results from the above mentioned TCs RAP, PIM, and 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.

Current TCs in Cluster F

Code	Title	TC Chair	TC Deputy Chair	TC opened in
264-RAP	Asphalt pavement recycling	Gabriele TEBALDI	Eshan V. DAVE	2015
272-PIM	Phase and interphase behaviour of bituminous materials	Emmanuel CHAILLEUX	Christiane RAAB	2016
278-CHA	Crack-healing of asphalt pavement materials	Hassan BAAJ	Orazio BAGLIERI	2016
279-WMR	Valorisation of waste and secondary materials for roads	Lily POULIKAKOS	Emiliano PASQUINI	2017
280-CBE	Multiphase characterisation of cold bitumen emulsion materials	Andrea GRAZIANI	Alan CARTER	2017
FBB	Fingerprinting bituminous binders using physico-chemical analysis	Bernhard HOFKO	Aikaterini VARVERI	2020 **NEW!**

Asphalt pavement recycling

264-RAP

Chair **Gabriele TEBALDI**
Deputy Chair **Eshan V. DAVE**
Activity started in 2015

TC 264-RAP leadership (chair, deputy chair and TG leaders) at the TC industry workshop in Granada, Spain, in June 2019. Courtesy of E. Dave.

Significance

• Recycling of asphalt materials has become a necessity due to the declining sources for new aggregates, increased costs, and environmental impacts of using asphalt.
• It is necessary to understand the role of recycled asphalt (RA) in new mixes and its interaction with other constituents, specifically rejuvenating agents, is urgently needed.
• Develop tools for asphalt (cold, warm and hot) mix designs using fundamental principles to sustainably utilize RA.

Relevance

• Academics, road authorities and standardization committees, testing laboratories and equipment producers, material and construction equipment producers, 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

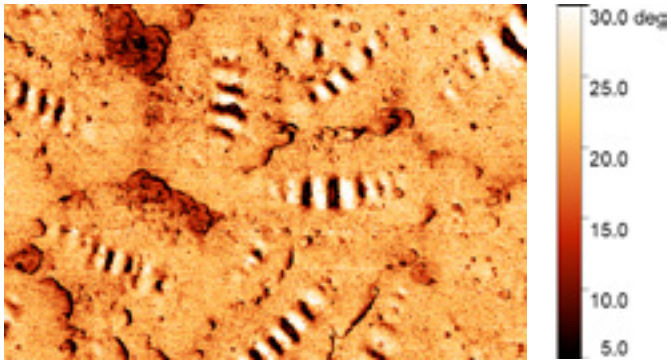
• Investigations are conducted at the laboratory evaluation and field assessment scales.
• Interaction with industries and road administration in different countries/continents.
• This TC is organized in the form of five task groups: TG1 Cold Recycling; TG2 Hot and Warm Recycling; TG3 Asphalt Binders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

Progress

• STAR is under development, 1st draft expected by September 2020.
• 6 RILEM recommendations are under development.
• 8 papers have already been developed.
• A special session will be held at the 74th RILEM Annual Week in September 2020.

272-PIM Phase and interphase behaviour of bituminous materials

Chair **Emmanuel CHAILLEUX**
Deputy Chair **Christiane RAAB**
Activity started in 2016



AFM image showing nanoscale structures in a pure bitumen. Courtesy of S. Nagar.

Bituminous materials are MULTIPHASE materials. Courtesy of E. Chailleux.

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:
• Go towards intrinsic evaluation, relevant to the actual field performance.
• Conduct studies at different scales: binder, mastics, mixture and pavement such as single layered structures.
• Understand bituminous materials as multiphase materials.

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.

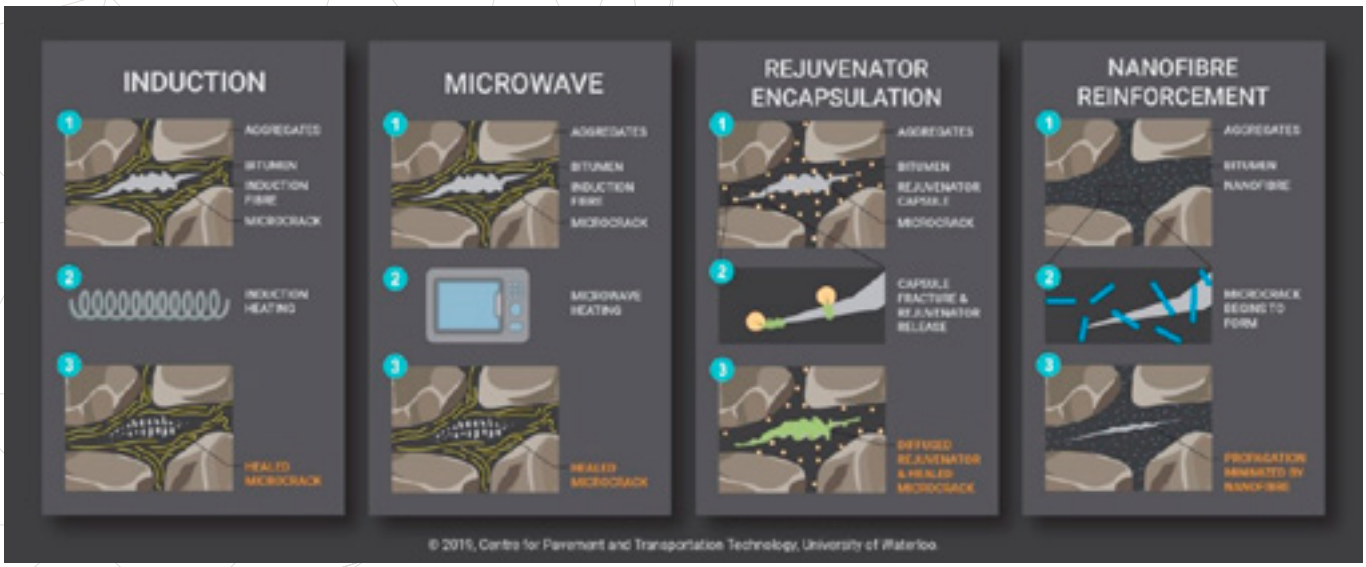
Progress

• Multiple publications are underway, including contributions to RILEM ISBM Lyon 2020.
• Experimental program of TG 1 closed in March 2020.
• Round Robin Tests of TG 2 (mixtures) and TG 3 (multilayer systems) are completed, results of 1st series are under assessment.

Crack-healing of asphalt pavement materials

278-CHA

Chair **Hassan BAAJ**
Deputy Chair **Orazio BAGLIERI**
Activity started in 2016



Different approaches to introduce additional self-healing performance (extrinsic) to bituminous materials. Courtesy of H. Baaj.

Significance

• Cracking is one of the most prevalent deterioration modes of flexible pavements leading to high maintenance and rehabilitation cost during their life cycle.
• Several academic and industrial researchers have been exploring Self-Healing Materials (SHM) to help create bituminous mixes with crack-healing capabilities and extended service life.
• No standard test methods are currently available for the evaluation of healing potential of bituminous materials with SHM.

Relevance

• Highly technically qualified engineers and material scientists who are sensitive to sustainable development and environmental issues.
• Academia, construction and building materials industries, engineering firms and governmental transportation authorities.

Goals

• Exploration of test methods and techniques for the induction of cracking in bituminous materials and for quantification of their healing potential.
• Development of technical criteria for the selection of materials with improved healing properties.

Methodology

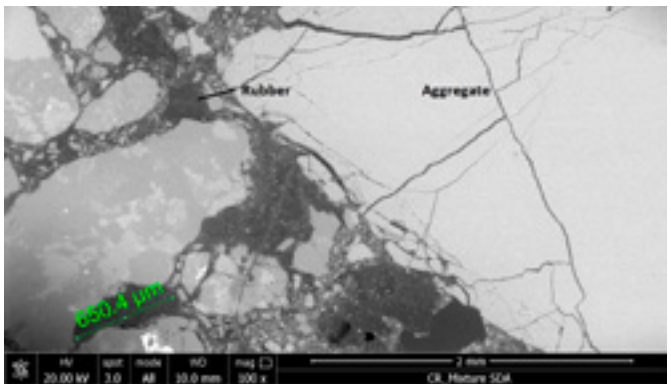
• TG1 (literature survey) has focused on i) cracking in flexible pavements and tests to induce and evaluate it, ii) different phenomena involved in the crack-healing process iii) investigating the different self-healing methods for bituminous materials.
• TG2 (laboratory experimentation) is currently investigating the different procedures for evaluating self-healing properties of bituminous binders and mixtures.
• TG3 (numerical modelling) aims to develop a numerical prediction cracking and healing of flexible pavement.

Progress

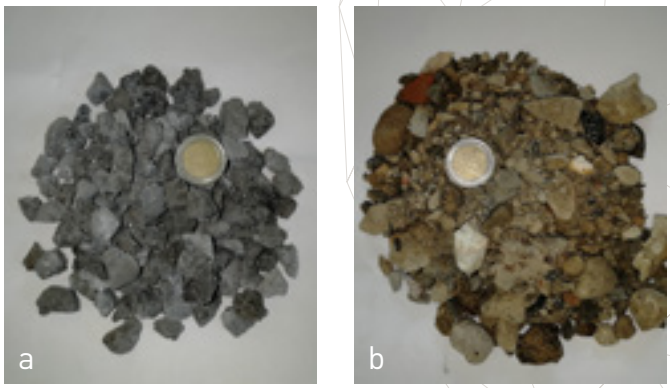
• STAR completed and to be published soon.
• TG2 experimental work is undergoing in 8 different universities and research institutions.
• Symposium on High Performance Asphalt Materials at the University of Waterloo, Ontario, Canada, in October 2019.
• Workshop on Crack-Healing of Asphalt Pavement Materials at Beijing University of Technology, Beijing, China, in December 2019.
• Two papers submitted to RILEM ISBM Lyon 2020: 1) Leegwater et al. "Terms and definitions on crack-healing and restoration of mechanical properties in bituminous materials" and 2) Baglieri et al. "Testing methods to assess healing potential of bituminous binders".

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

Chair **Lily D. POULIKAKOS**
Deputy Chair **Emiliano PASQUINI**
Activity started in 2017



ESEM micrograph of crumb rubber. *Frontiers in Built Environment* (2020) 6:41.



a) Steel slag; b) Construction and demolition waste. Courtesy of E. Pasquini.

Significance

• Use of various waste materials in roads can be a technically viable option without compromising performance and with significant savings in CO2 and energy. However, the primary barrier for use of waste materials is knowledge and the scientific community needs to make a more significant effort to bring the acquired knowledge to the practicing professionals.

Relevance

Targeted users are:
• Academics, material producers, road authorities, and standardization committees.
• Testing laboratories and test equipment producers.
• Professionals and practitioners which have to solve non-routine problems.

Goals

• Identifying waste materials that have a potential to be performance enhancing components for road materials.
• Enhancing the knowledge of suitable binder additives and their performance and appropriate aggregate substitutes and their performance.
• Identifying innovative and appropriate testing procedures that eliminate risk to workers' health and the environment.
• Demonstrating that these materials have reduced environmental impact.
• Providing recommendations about suitable waste materials and their amounts for use in roads.

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 and potential sources of pollutants.
• TG5 will perform Life Cycle Assessment.

Progress

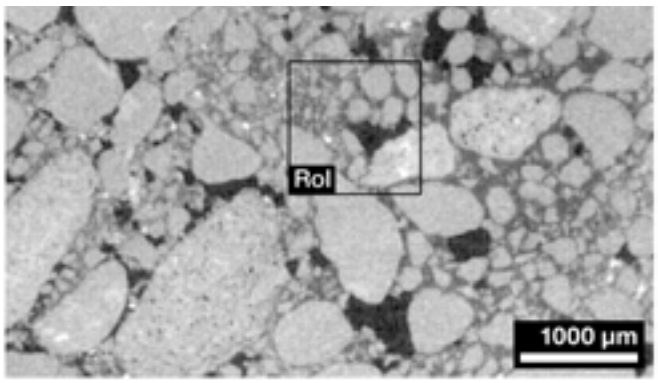
• M. Pasetto et al. (2020) "An interlaboratory test program on the extensive use of waste aggregates in asphalt mixtures: preliminary steps", Accepted for RILEM International Symposium on Bituminous Materials – ISBM Lyon 2020, Lyon, 2020.
• The work program including material's selection and round robin tests has been defined. The materials have been delivered to the participating laboratories. The round robin tests are ongoing. Various publications reporting on the preliminary results have been prepared.

Multiphase characterisation of cold bitumen emulsion materials

280-CBE

Chair **Andrea GRAZIANI**
Deputy Chair **Alan CARTER**
Activity started in 2017

Cohesion test on bituminous slurry surfacing. Courtesy of C. Sangiorgi.



XCT image of bitumen emulsion-cement mortar. Courtesy of M. Miljkovic.

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.

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.

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.

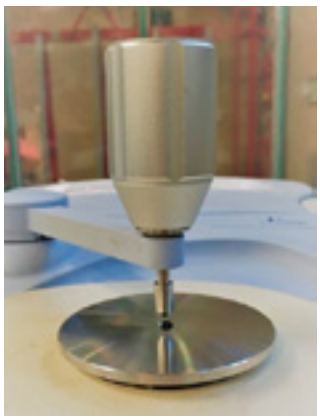
Progress

• Grilli et al. (2019) Slurry surfacing: a review of definitions, descriptions and current practices, *RILEM Technical Letters,* 4, 103-109.
• TGs are currently performing inter-laboratory tests, 25 laboratories and 3 companies are involved in total.
• Completion of experimental work is planned in 2021, followed by preparation of report and recommendations in the final TC years (2021/2022).

FBB

Fingerprinting bituminous binders using physico-chemical analysis

Chair **Bernhard HOFKO**
Deputy Chair **Aikaterini VARVERI**
Activity started in 2020



Bitumen sample on the crystal area of the FTIR-ATR top-plate. Courtesy of A. Varveri.

Bitumen sample ready to be tested in a dynamic shear rheometer (DSR). Courtesy of B. Hofko.

Significance

Bitumen is an organic material and it is prone to ageing. Aging causes an increase of brittleness and stiffness, and thus, of the risk for cracking. We need to track oxidation in bitumen to ensure long-lasting and sustainable infrastructure. Life-time of transport infrastructure can also be achieved by modifying bitumen with various polymers. However, simple and standardized analysis methods to detect polymers in bitumen are missed.

Relevance

- RILEM TC FBB is interesting for researchers in the field of pavement materials and engineering, for partners from the bitumen production and supply industry and for road owners that could use tools for quality control.

Goals

- Gathering existing knowledge on physico-chemical analysis of bituminous binders and chemo-mechanics by a literature study.
- Improving the methodology and develop data for statistical information of infrared spectroscopy (FTIR) on bituminous binders as a basis for future standardization in a round robin experiment.
- Identifying potential methods for chemo-mechanical fingerprinting of modified binders.
- Providing recommendations for standardization of FTIR and methods for fingerprinting.

Methodology

- Improving FTIR procedure for bitumen analysis.
- Providing the basis for standardized analysis of bitumen modification and its oxidative ageing.
- Implementing other rheological, spectroscopic and microscopic techniques to be used to link physico-chemical with rheo-mechanical information.
- Generation of literature review, performance of round robin experiments and continuous discussion and analysis of results in online and in-person meetings.

Progress

RILEM TC FBB has been approved by the RILEM board in spring 2020 and will hold its kick-off meeting in September 2020.

Contributors to the 2019-2020 Technical Report

Legend

Affiliation to University or Teaching Institute
Affiliation to Industry, Research Centre or Government body
Female member
Male member

TC Chairs

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Concluding remarks

Re-Su-R-Ge
Resilience – Sustainability – RILEM - Gender

As in most conversations this year, it is impossible to avoid talking about the Covid-19 pandemic and how it has influenced our work, social interactions and life, in general. Being no exception, we begin our concluding remarks of the Second RILEM Technical Report in the same manner. So, how has COVID-19 affected RILEM and its members, and how could it shape future RILEM activities?

As we assess the situation, we hope that the opportunities that have arisen during these trying times outweigh the difficulties and economic consequences. The financial effect of the epidemic, which has affected practically everyone, is expected to have a strong impact on PhD students and early-career researchers, especially those who have lost precious laboratory time and face funding cuts, though it could also stimulate development of new areas of research (such as surfaces that are easier to disinfect or that are virus-phobic) and disciplines related to resilience and disaster mitigation. All of us have experienced the marvels of online communication through the different resources available, and even felt that the reduction of travel funding may not restrict conferences and meetings from taking place. Certainly, **things are going to be different, though not necessarily worse.**

Collaborative and interdisciplinary projects, a hallmark of RILEM, could provide more solutions to mitigate the limitations mentioned earlier. Furthermore, RILEM continues its efforts to encourage the activity of younger members by offering, for instance, low membership fees for PhD students and grants to attend RILEM events. A milestone was the recent TAC emphasis on facilitating new members to join technical committees, especially when they are young and ready to investigate new topics. Other recent initiatives for the benefit of young minds include 1) the East African Student Seminar on Materials Technologies for Sustainable Construction, held in Tanzania in February, and 2) the new series of online workshops "ROC&TOK" **– RILEM Online Conferences & Transfer of Knowledge Series.**

These past months have also reiterated the need to be more multidisciplinary, with wide-ranging and different perspectives leading to better quality, which could be envisioned for RILEM outcomes and activities, as well. The primary scientific disciplines within RILEM are Civil, Chemical, Mechanical and Materials engineering. Physicists, Chemists, Architects, just to mention a few, could be made more welcome onboard!

The 73rd RILEM Annual Week in Nanjing, China, in August 2019, is fresh in our minds, with the hospitality matching the grandeur of the venue and the quality of the interactions. The 74th RILEM Annual Week in Sheffield, UK, in August 2020, will have a different flavour, as it is planned as a fully online event. Nevertheless, it promises to be the flagship event

for RILEM this year. The learning from the 3rd RILEM Spring Convention in Guimarães, Portugal, in March this year, was important, as the format of the conference changed in a matter of hours from the conventional "in person" to online "remote"… The ability to adapt to the circumstances provided a unique experience for all participants, those who were in person at Guimarães, and those who connected from their offices and homes. Thanks to Eduardo Pereira and his team, the 2020 RILEM Spring Convention became an excellent example of the **resilience** of researchers and the RILEM family.

Undoubtedly, the environment is taking advantage of the lockdowns imposed almost everywhere by the epidemic. No flights in the sky, no cars on the freeways, no factories polluting air and water… This "break" has reminded us yet again about the opportunity to straighten up our act and made us believe more in the resilience of humanity and the planet Earth. **Sustainability,** a word over- and mis-used often in the past, should be fundamental in the way forward. RILEM will continue to have sustainability in the headlines of its activities; one such initiative that is shaping up well is what is becoming popularly known as the Globe Manifesto,(globe.rilem.net), which brings together experts from different fields for formulating guidelines for more sustainable built environments.

Recently, António Guterres, the Secretary-General of the United Nations, tweeted that "Women's leadership and contributions must be at the heart of coronavirus resilience & recovery efforts". This coincides with the continuing consideration of **gender** balance within RILEM to bring about holistic progress and multifaceted impact. Though RILEM has had only 2 women Presidents, Prof. Rachel Shalon in 1960 and Dr Carmen Andrade in 2000-2003, we have now many female officers in RILEM. I am pleased to recognize the able leadership of Nele De Belie as the TAC Chair, Karen Scrivener as the EAC Chair and Alexandra Bertron as the Editor in Chief of *RILEM Technical Letters,* along with Karen Scrivener (TC 267-TRM), Nele De Belie (TC 281-CCC), Barbara Lubelli (TC 271-ASC), Ioanna Papayianni (TC 277-LHS), Antonietta Aiello (TC IMC) and Lily Poulikakos (TC 279-WMR) who currently chair Technical Committees, among others. Overall, a gender analysis of RILEM shows that female members represent 30% of the membership. There is still a long way to go, though the future evidently promises to be brighter. We cannot desist from emphasizing the decisive role played by the team of outstanding staff at the Secretariat General in Paris: Judith Hardy - Secretary General, Anne Griffoin - Head of Publications and Communication and Fanta Sylla - Management Assistant. Judith took over from Pascale Ducornet and Fanta joined RILEM more recently, both within the past year. We also have Daniela Ciancio, the RILEM Implementation Manager, who is always in the midst of all the happenings at RILEM and is the inspiration for the tone and thoughts expressed here.

We believe that RILEM members have all been healthy and safe, though there may have been less fortunate ones in their communities, for whom we dedicate our solemn thoughts. It is reassuring that the RILEM family is strong and resilient, and we look forward to walking out of the difficult situation together, hand-in-hand again.
This has been a challenging time for all of us, and we wish that everyone continues with good health and positive spirits to resurge from the restrictions and difficulties, with new ideas and renewed values. Looking forward to connect with all of you virtually but soon again physically and talk about our friendships and perspectives.

From the left: Nicolas Roussel (Vice President), Anne Griffoin (Head of Publications and Communication), Fanta Sylla (Management Assistant), Judith Hardy (Secretary General), Daniela Ciancio (Implementation Manager), Johan Vyncke (Past President) and Ravindra Gettu (President)

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