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

2020
2021

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

Young Member **NEW!**	€ 25	Retired Member	€ 75
Senior Member	€ 375		

Corporate fees in 2020

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

Note that special discounts of between 40% and 60% on membership fees apply depending on your country of residence. Please consult the website **membership.rilem.net** for details.

Editorial

by RILEM TAC Chair Nele De Belie

I am proud to present you the third edition of the RILEM Technical report. I am tempted to call it the "COVID-19" edition, for obvious reasons. It has been a different year, sometimes tough and challenging, sometimes dull and boring. I do hope that all RILEM members and their families are doing fine, and my thoughts go to those that have lost someone in the last 12 months due to this horrific virus. RILEM is a family, and as such we share happiness and grief, good moments and bad moments.

The most evident impact of the pandemic in this report is the type of images used to describe the activities of the RILEM Technical Committees. You will see in the following pages a predominancy of screen shots of online meetings. This has been the "new" way of interacting. The good thing about virtual meetings is that TC members can attend them, independently from the COVID-restrictions and financial resources to travel to the meeting venue. The negative thing is that we all miss a hug from our colleagues and friends and to share a cup of coffee.

The first fully-online RILEM event took place in September 2020. It was a tough decision to turn the 74th RILEM Annual Week and 40th Cement and Concrete Science Conference from an "in-person" to a "virtual" conference. This nasty pandemic forced the organisers to take the decision *"to move the conference and all associated committee meetings to an online format".* The event was anyway a success! The general feeling was that a fully-online high-quality conference is possible. The warmth of the face-to-face chats at the coffee breaks was not there but the exchange of ideas and useful discussions with colleagues and peers were still guaranteed. You can read more about this event in the 2020 RILEM Annual report.

The 4th RILEM Spring Convention, in April 2021, was initially planned to be the celebration of the 75th RILEM Anniversary in the same town where the association was founded 75 years ago, Paris! However, the decision was taken to postpone the celebration to 2022, still in Paris, hopefully in person, and to make the 2021 event fully online. You can read more about this event, that happened in conjunction with the 2021 RILEM Strategic Workshop, in the following pages.

In the last 12 months, TAC has approved 9 new Technical Committees and closed 4 of them. I would like to congratulate the TC Chairs, Deputy Chairs and TC members of the closed TCs for their amazing work and wish the leaders and participants of the new TCs all the best in the future years. I also want to acknowledge the work of the Cluster Conveners that provide assistance and guidance to the TC chairs.

At the last TAC meeting "in" Paris, we approved the initiative of having sub-committees in languages different from English, as long as the convener of the sub-committee speaks fluent English and can report the discussion to the TC Chair and Deputy Chair. We hope to encourage the participation into the RILEM TC activities of researchers, professionals, scientists and PhD students that are not fluent in English! On this subject, there was the discussion about the opportunity to co-sponsor non-English events (conferences,

workshops, etc…). TAC will be pleased to consider such applications (still in English)! The form is available online.

Another important decision was about the invitation of a RILEM Youth Council (RYC) representative to sit in TAC, as observer. By doing this, we aim to improve the collaboration with the RYC and work together towards the same goal, that is, increasing the participation of young members in the activities of the RILEM TCs. You can read more about the recently established RYC in the following pages.

The next TAC meetings will be held in September 2021, on the occasion of the 75th RILEM Annual Week in Merida, Mexico, (hybrid event) and in March 2022, on the occasion of the 5th RILEM Spring Convention in Paris, France. RILEM is happy to continue to maintain the hybrid format of its events, independently from the evolution, and hopefully end, of this COVID-19 pandemic. I look forward to meeting you all again in person, soon!

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An overview of the 4th RILEM Spring Convention and Strategic Workshop

6-9 April 2021 (online)

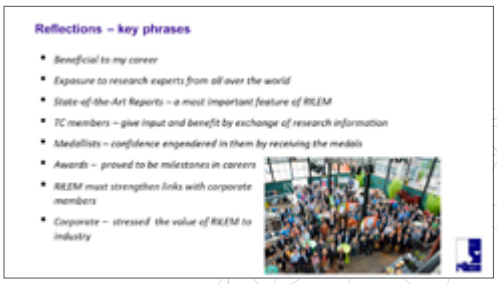
The 4th RILEM Spring Convention took place in April 2021, "in" Paris, France. The event was initially planned to be the celebration of the 75th RILEM Anniversary in the same town where the association was funded 75 years ago. This interminable COVID pandemic, however, has forbidden us from travelling and meeting in person this spring so the decision was taken to postpone the celebration to 2022, still IN Paris, hopefully IN person, and to make the 2021 event fully online. This decision has definitively affected the amount of wine and cheese and chocolate consumed over the event this year, and it has also influenced the number of hugs and hand-shakings between RILEM members and friends (unfortunately equal to zero). However, the amount of smiles, laughs, good ideas and project proposals does not seem to have been altered by the online mode.



We missed the French wines, chocolates and cheeses this year at the online RILEM Spring Comvention "in" Paris, France. Image courtesy of unplash.com.

Within the 4th Spring Convention, the RILEM Strategic workshop definitively holds a special place. On Tuesday 6th April, around 120 people from all over the world joined the opening ceremony whose video is available on the RILEM YouTube Channel. During this session, Mark Alexander, RILEM President in 2012-2015, together with Ravindra Gettu, current

A slide from Prof. Alexander about the key-phrases from the RILEM members included in the 75th RILEM Anniversary Booklet.



Some concluding remarks by Johan Vyncke, RILEM outgoing President, about the paths to follow in the future of RILEM.

RILEM President and Johan Vyncke, current RILEM outgoing President, presented the RILEM History Booklet. This was just a preview of the booklet as it will be officially launched and distributed in September this year, during the 75th RILEM Annual Week. This is the third book published about the history of the association since its foundation: the first one marked the 30th anniversary, the second the 50th anniversary and this last one the 75th anniversary. This booklet highlights the major changes of the association in the last two decades and it puts a special emphasis on the members' personal reflections and anecdotes. It also presents some interesting conclusions about the importance, in the future of RILEM, of digitalization processes, automation, impact on human health, carbon-neutral construction and circular economy. The latter ones are already hot RILEM topics rooted in the recent initiative GLOBE.

With the GLOBE initiative in mind, the RILEM members that signed in to participate in the Strategic workshop were invited to join the parallel sessions at the end of the Opening Ceremony. The themes of the parallel sessions were: Young members, Industry, Dissemination, Online digital tools, Rilem values, DAC-Presidency list of items (attended by about 14 people). Each session was chaired by a moderator and a reporter.

The conclusions of each session were presented at the end of the day. The outcomes/ proposals of this workshop will be discussed at the RILEM Standing Committees (TAC, EAC and DAC) next September during the 75th RILEM Annual Week where approval will be issued by Bureau and confirmation by the General Council through the votes of the RILEM members.

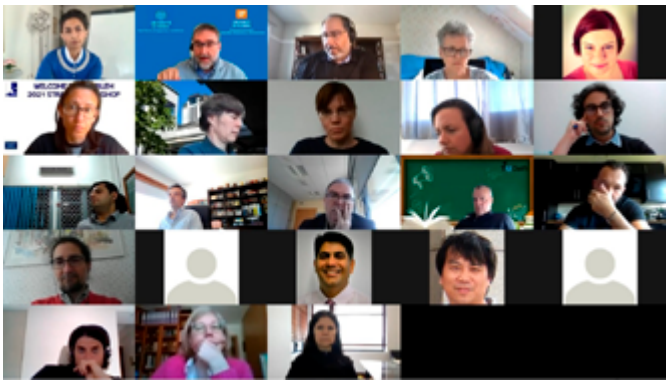
Wed 7th April was the day of the Standing Committee meetings, TAC, DAC and EAC.

Thursday 8th April was entirely occupied by the Bureau meeting, where many items were presented from the meetings of the day before and approved.

A slide from Johan Vyncke's and Daniela Ciancio's presentation about the proposed themes for the 2021 RILE Strategic workshop.

Updates from TAC

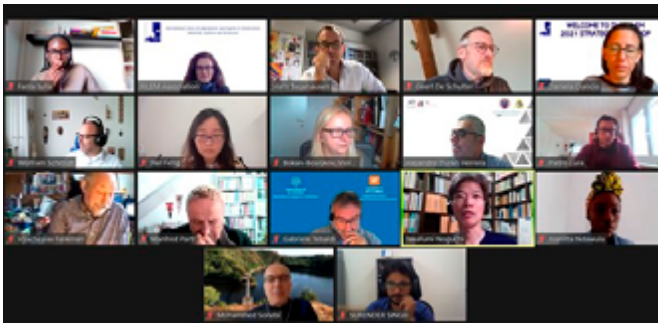
- Four new TCs were approved:
  - o ADC: Assessment of Additively Manufactured Concrete Materials and Structures, chaired by Viktor Mechtcherine.
  - o PFC: Performance requirements and testing of fresh printable cement-based materials, chaired by Nicolas Roussel.
  - o FEE: Fume emissions evaluation for asphalt materials, chaired by Johan Blom.
  - o CNC: Carbon-based nanomaterials for multifunctional cementitious matrices, chaired by Florence Sanchez.
- Two TCs were assigned a number:
  - o 292-MCC: Mechanical Characterization and Structural design of Textile Reinforced Concrete, chaired by Barzin Mobasher.
  - o 293-CCH: Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete-Reinforcing Steels, chaired by Javier Sanchez Montero.
- The following TCs were closed:
  - o 260-RSC: Recommendations for use of superabsorbent polymers in concrete construction, chaired by Viktor Mechtcherine.
  - o 276-DFC: Digital fabrication with cement-based materials, chaired by Nicolas Roussel.



Screen shot during TAC meeting. From the left of the top first row: Daman Panesar, Gabriele Tebaldi, Hassan Baaj, Karen Scrivener, Anne Griffoin. From the left of the second row: Daniela Ciancio, Nele de Belie, Anya Vollpracht, Alexandra Bertron, Enrico Sassoni. From the left of the third row: Arun Menon, Miguel Azenha, Giovanni Plizzari, Erik Schlangen, Nicolas Roussel. From the left of the forth row Michael Witsuba, Eshan Dave, Guang Ye. From the left of the fifth row: Fragkoulis Kanavaris, Esperanza Menendez Mendez, Josee Duchesne.

Updates from DAC

- Mohammed Sonebi's mandate as Regional Convener for Middle East & North Africa area has been extended to 2023, as Prof Sonebi is member of the 2023 RILEM Spring Convention board, taking place in Rabat, Morocco.
- DAC expert Manfred Partl, whose mandate expired this year, has been replaced by Gabriele Tebaldi, (1st mandate).
- Arnaud Castel, from the University of Technology, Sydney, Australia, was welcome as Regional Convener for the Pacific area (1st mandate).
- This DAC meeting has been attended for the first time by the Chair and the Vice-Chair of the RILEM Youth Council, formed last year.



Screen shot during DAC meeting. From the left of the top first row: Fanta Sylla, Judith Hardy, Hans Beushausen, Geert de Schutter, Daniela Ciancio. From the left of the second row: Wolfram Schmidt, Pan Feng, Violeta Bokan Bosiljkov, Alejandro Durán-Herrera, Pietro Lura. From the left of the third row: Vyatcheslav R. Falikman, Manfred Partl, Gabriele Tebaldi, Takafumi Noguchi, Joanitta Ndawula. From the left of the fourth row: Mohammed Sonebi, Surender Singh.

Updates from EAC

• RILEM Annual Week doctoral courses week will be offered in an online mode.
• ROC&TOK webinar series launched in November 2020 is very successful and the programme of speakers and topics for 2021 is complete.

A particular thanks goes to the group of PhD students (Rohit Prajapati, Bipina T V, Vaishnav Kumar Shenbagam, Asha B) at the Indian Institute of Technology, Madras, India, for the technical help and assistance they provided before and during the workshop. The organisation and execution were flawless, and participants moved smoothly from one session into the other without delays… thanks to their help!

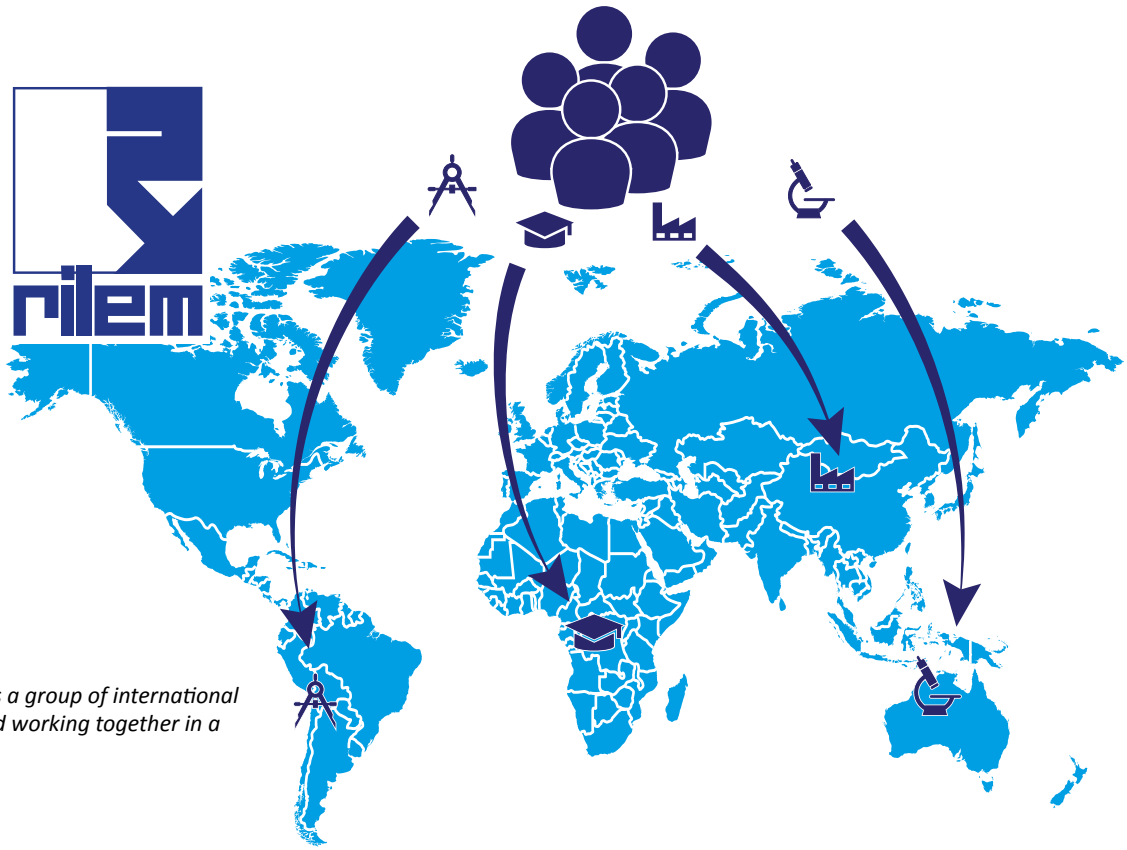
Another note of merit goes to the RILEM members from India, Japan and China for staying connected till the end of all meetings at around 6 pm Paris time (past 10 pm in the above-mentioned countries). Even more impressive was the commitment of the RILEM members from USA and Latin America who woke up very early (or even didn't go to bed at all) to attend the morning sessions of the event. THANK YOU!!!

Friday 9th of April was the day of the *International RILEM Conference on Early age and long-term crack width in RC structures* (CRC 2021), organised by the homonymous RILEM Technical committee 287-CCS. This event saw 34 presentations whose papers are included in the conference Proceedings published by Springer. Around 210 registered participants joined the event, 12 of which in person. The organisers are very pleased with the outcomes of the event as there was a good balance between attendants from research institutions, industry and standard and drafting committees. The highlight of this event was the performance of the conference overwhelming the expectations of the organisers: they anticipated 50-60 participants but they ended up with an audience 4 times bigger! This marked the relevance of the conference to research and engineering practice needs.

Screen shot during EAC meeting. From the left of the top first row: Pan Feng, Fanta Sylla, Mette Geiker. From the left of the second row: David Orense, Karen Scrivener, Doug Hooton. From the left of the third row: Nele de Belie, Prannoy Suraneni, Marijana Serdar.

Screen shot of CRC2021 participants. Picture courtesy of Farid Benboudjema.

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.

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 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, 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 2019 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 all RILEM proceedings of conferences (published by RILEM Publications and Springer).
- 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 Robert 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

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

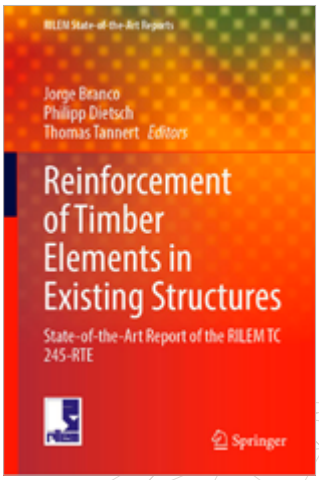
The mission of RILEM is "to advance scientific knowledge related to construction materials, systems and structures and to encourage transfer and application of this knowledge world-wide". This mission is achieved through the outstanding work of the RILEM Technical Committees and the dissemination of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

State-of-the-Art reports (STAR)

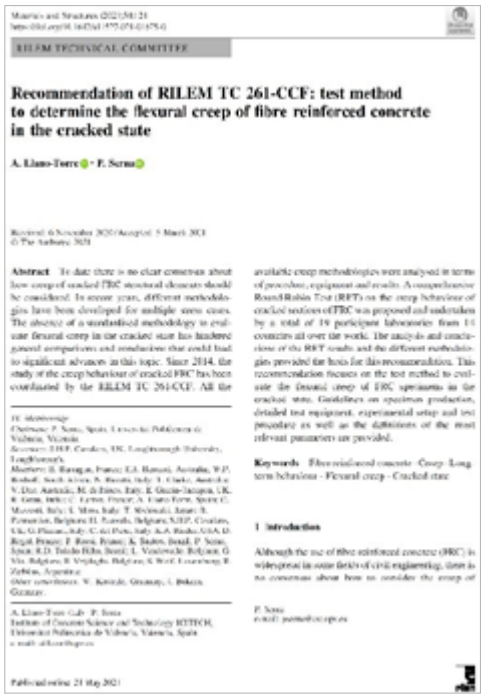
These reports constitute a critical appraisal of current knowledge on a specific research subject. They often identify gaps in knowledge, thereby contributing to the development of strategies and scenarios for future research. Since 2009, RILEM State-of-the-Art reports are published by Springer and they 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.

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 and 3) to clarify the relevance of the contents before downloading or purchasing the full document for further details. The "STARs in a Nutshell" can be downloaded for free from our website.



Cover of STAR of TC 245-RTE. Courtesy of Springer.



RILEM TECHNICAL COMMITTEE

Recommendation of RILEM TC 261-CCF: test method to determine the flexural creep of fibre reinforced concrete in the cracked state

A. Llano-Torre · F. Serna

Recommendation of RILEM TC 261-CCF. 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.

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 Publications S.A.R.L. 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 35 volumes in this RILEM Bookseries, available here.

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's Technical Committees.

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

RILEM Technical Letters

RILEM Technical Letters Journal 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* journal is published as a *Diamond Open Access* journal available online free of charge. The articles are submitted on invitation by the Editorial Board but the journal has recently also opened the possibility of submitting spontaneous contributions. Many articles are technical reports of the activities of the RILEM TCs. *RILEM Technical Letters* has been recently indexed in Scopus and in the Directory of Open Access Journals. The acceptance to these prestigious bibliographic databases follows a high-quality evaluation process by an independent board of experts.

RILEM technical letters

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

Industry endorsements

Here are a few extracts taken from the interviews with some RILEM members who are from the industry sector. Their contribution to RILEM, like the contribution of all RILEM members, comes "for free"; in other word, none of the RILEM members, including the Presidents and the Chairs of the Standing Committees, perceives a remuneration for their work in and for RILEM. It is all done on a voluntary base!

Dr Fragkoulis Kanavaris.

From the interview in October 2020 with Dr Fragkoulis Kanavaris, Concrete Materials Specialist in the Department of Specialist Technology and Research - Advanced Digital Engineering at ARUP in London, and Deputy Chair of TC 287-CCS : Early age and long-term crack width analysis in RC Structures.

RIM: … I would like to know how your supervisors at ARUP see your engagement and commitment with RILEM. What do they think of RILEM?

Dr Kanavaris: As you know, industry companies and firms are very much project and income driven. RILEM is based on voluntary contributions from self-motivated members. This does not bring any profit to a firm but it does bring prestige, credibility and knowledge. Now… there are firms that appreciate that and there are firms that do not. I was lucky enough, again, as ARUP is at the forefront of innovation in the civil engineering business and in my department these values are highly appreciated.

Dr Kanavaris: … I advertise RILEM all the time, for instance by posting RILEM news about useful recommendations or an interesting conference or any worthwhile research activity, in our global forum so that everyone in my firm can see it. For example, at the moment ARUP is involved in the design of several underground tunnels using fibre-reinforced concrete/ shotcrete. Many colleagues have questions about the calculation of crack width, and I can direct them to some very helpful RILEM publications on this matter.

RIM: … What about the issue of the time frame of RILEM TCs and the pace at which TC outcomes are published, compared to the much faster pace at which the industrial sector normally acts?

Dr Kanavaris: In the industry, you are often pushed to produce an outcome. In a RILEM TC you do not necessarily work under pressure. You are given the time to develop something following a group's pace which will satisfy the needs of the current engineering challenges and the practical time commitment, which is voluntary, of the TC members. You cannot apply pressure on TC members who are not paid to develop the outcomes of a TC. Also, it always comes down to group dynamics as there can be TCs that are more fast-paced than others productivity-wise.

From the interview in November 2020 with Dr Jose Pacheco Principal&Group Director of Concrete&Cement-Based Materials at CTLGroup in Skokie, IL, US.

Dr Jose Pacheco.

Dr Pacheco: …The part that I like about RILEM is related to my research-oriented mind where I can really dive deep into specific topics. I think that RILELM is great at that! … I want to help with this industry endorsement because I think that somehow there is a misunderstanding of what RILEM actually does and people believe that it is only for researchers or only for people in the universities, where actually it is not! It is very rewarding for people that are in consulting like I am, or people representing owners.

RIM: … Like for all RILEM members, also your work is based on a voluntary basis. It means that when you stop working as a consultant you start to work as a RILEM member...

Dr Pacheco: Yes! It is my hobby! ☺ I think this is the same for everyone. Even with ACI it is the same: the contribution of members is voluntary. But I do not see this as a burden. I see this as an actual part of a professional development that any consultant needs to do, to connect with more people, to be up to speed with what is going on with the latest research, so that you can provide a better consulting service to your clients. Overall I think that, in the settings that RILEM has, what I have always appreciated is that it is very focused on the science and what the actual results are.

RIM: I really like this image of RILEM members as a group of detectives and the research outcomes as the "solving the crime"…

Dr Pacheco: Sometimes the crime cannot be solved! That is what actually happened with TC 235-CTC. Let's put it this way: we were not able to solve the crime the way we wanted and then this new committee that Ueli Angst and Mette Geiker started (editor's note: RILEM TC 262-SCI: Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion) contains many members of TC 235-CTC "Corrosion initiating chloride threshold concentrations in concrete" that continued working on this topic plus new members that is always exciting. I am really looking forward to seeing what the next committee is going to be about, how it is going to be formed and all of that!

RILEM Youth Council

RILEM YOUTH COUNCIL

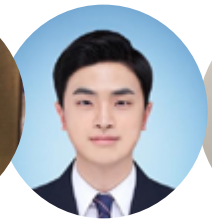
JOANITTA NDAWULA
RYC Chair

SURENDER SINGH
RYC Vice-Chair
South Asia

DAVID ORENSE
Marketing and communication Manager
North America & The Carribbean

MAGDA POSANI
RYC Secretary
Europe

Marie Joshua Tapas
Pacific



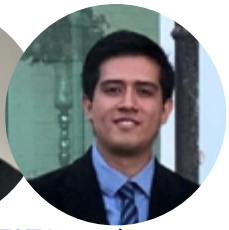
Heongwon [redacted]
East Asia

Bo Ran
China

Nonkululeko W. Radebe
Sub-Saharan Africa

Said Bouzit
Middle East & North Africa

Evgenii RUMIANTSEV
East Europe & Central Asia



José Vidal González AVIÑA
Latin America

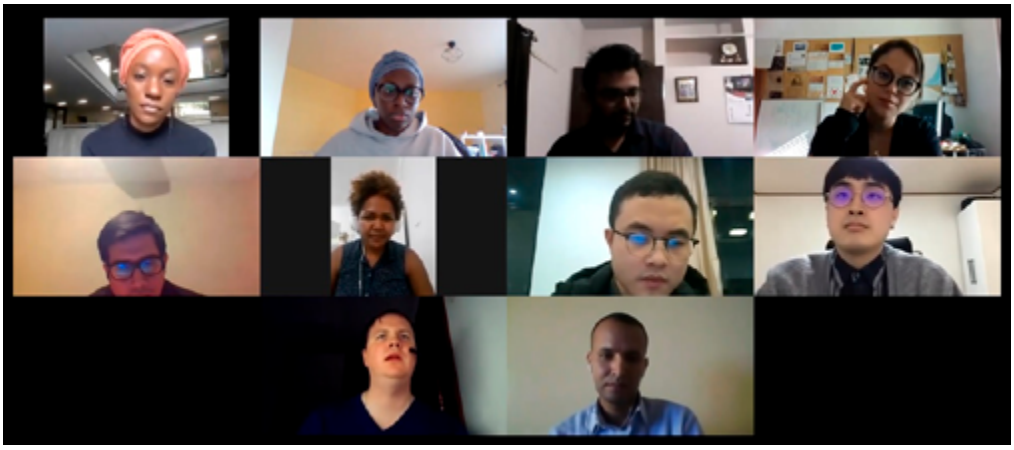
Approved during the 74th RILEM Annual Week in Sept 2020, the RILEM Youth Council (RYC) was created as a sub-committee of the Development Advisory Committee (DAC). Its main tasks are:

- attracting and motivating new young RILEM members
- encouraging participation in TAC and EAC activities
- increasing awareness of RILEM events and courses
- preparing young members for leadership positions
- showcasing / celebrating the achievements of the RILEM Youth
- creating networks between emerging researchers to increase visibility of / access to RILEM.

The RYC had its kick-off meeting in December 2020. The Council members, all PhD students or recently graduated PhDs in the early stages of their academic careers are:

- RYC Chair: Joanitta NDAWULA, University of Cape Town, SOUTH AFRICA
- RYC Vice-Chair: Surender SINGH, Indian Institute of Technology Madras (IITM), INDIA (South Asia)
- RYC Marketing & Communication Manager: David A. ORENSE, Penn State University, UNITED STATES (North America & Caribbean)

- RYC Secretary: Magda POSANI, LNEC - National Laboratory of Civil Engineering, PORTUGAL (Europe)
- Nonkululeko Winnie RADEBE, Karlsruhe Institute of Technology (KIT), GERMANY (Sub-Saharan Africa)
- Heongwon SUH, Hanyang University, SOUTH KOREA (East Asia)
- Bo RAN, Tsinghua University, CHINA (China)
- Said BOUZIT, University Ibn Zohr, MOROCCO (Middle East and North Africa)
- Evgenii RUMIANTSEV, Pik-project, Ltd, RUSSIAN FEDERATION (East Europe & Central Asia)
- José Vidal González AVIÑA, Autonomous University of Nuevo Leon, MEXICO (Latin America)
- Marie Joshua TAPAS, University of Technology Sydney, AUSTRALIA (Pacific).



Screen shot of the kick-off meeting of the RILEM Youth Council. Top row, from the left: Joanitta Ndawula, Fanta Sylla, RILEM Management Assistant, Surender Singh, Magda Posani. Middle row, from the left: José Vidal González Aviña, Marie Joshua Tapas, Ran Bo, Heongwon Suh. Bottom row, from the left: Evgenii Rumyantsev, Said Bouzit. Image curtesy of J. Ndawula.

The RYC Chair and Vice-Chair sit at DAC meetings during which they report their activities. At the last (4th) RILEM Spring Convention in April 2020, it was decided to have RYC representatives sitting also in TAC and EAC meetings, as observers.

One of the goals of the RILEM Youth Council for 2021 is to get at least 200 new RILEM Young members before the end of the year. The Council launched this initiative in Feb this year. Since the implementation of RYC initiatives, there has been a significant increase in the Young membership of RILEM!

The members have been busy presenting at various events, like for instance, at the 1-day RILEM conference "Materials and value chains for sustainable, inclusive, and resilient urbanisation in Africa" and the Concrete Institute of Australia webinar "The Pathway to Greener Concrete".

The Council has also recently launched the new Instagram RILEM Youth account @RILEMYouth! With their infographics, they inform their followers about how RILEM works, and they circulate the most recent news of RILEM!

EAC ROC&TOK Webinars

In November 2020, the RILEM Educational Activities Committee (EAC) launched a new monthly webinar series, *RILEM Online Conferences & Transfer of Knowledge (ROC&TOK)*, designed to give information about how to communicate and teach subjects, related to the activities of RILEM and its technical committees.
The aim of this series is to bring new, untaught or updated research into the classroom as well as new pedagogy on how to teach these topics. The webinars have been a refined and thoughtful approach to what should be taught and how it should be taught. Lecturers consolidate and summarize research that can be conveyed to undergrad and grad students.
Each webinar is scheduled with a 30-min presentation followed by a 30-min Q&A session.
The webinars, delivered by internationally renowned experts, have taken place live online on the first Thursday of each month since November 2020, except for January and August.

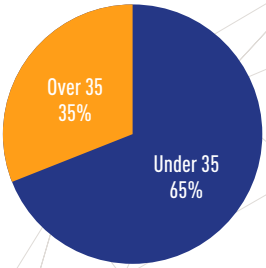
The opening webinar, "Cement and CO2, the reality", was on Thursday 5 November 2020 and it was hosted by Prof. Karen Scrivener, Ecole Polytechnique Fédérale de Lausanne, Switzerland. Eight webinars have been offered up to the time in which this report is written, the details of which can be found in the table below.

Date	Title	Lecturer	# participants
Jul-21	Digital concrete: Dream or reality? New green or ecological monster	Dr Robert Flatt, ETH Zurich, Switzerland	275
Jun-21	Alkali-Silica Reaction: Research Needs and the Link to Practice Description	Prof. Jason Ideker, Oregon State University, United States	243
May-21	Rheo-physics and shaping of fresh cement-based materials	Dr Nicolas Roussel, Research Director, Laboratoire Navier, Université Gustave Eiffel, France	280
Apr-21	Corrosion and electrochemistry of steel in concrete	Prof. Ueli Angst, Durability of Engineering Materials Research Lab, ETH Zurich, Switzerland	268
Mar-21	Hydration and performance of Limestone Calcined Clay Cement	Prof. Shashank Bishnoi, Indian Institute of Technology, Delhi, India & Prof. Fernando Martirena, Universidad Central de las Villas, CIDEM, Cuba	249
Feb-21	Thermodynamic modelling: a tool to understand hydrated cements	Prof. Barbara Lothenbach, Group Leader Cement Chemistry and Thermodynamics, Empa, Switzerland	297
Dec-20	Shrinkage Reducing Admixtures - Their Science and Role in Education	Prof. Jason Weiss, dwards Distinguished Chair of Engineering, Oregon State University	180
Nov-20	Cement and CO2, the reality	Prof- Karen Scrivener, Ecole Polytechnique Fédérale de Lausanne, Switzerland	228

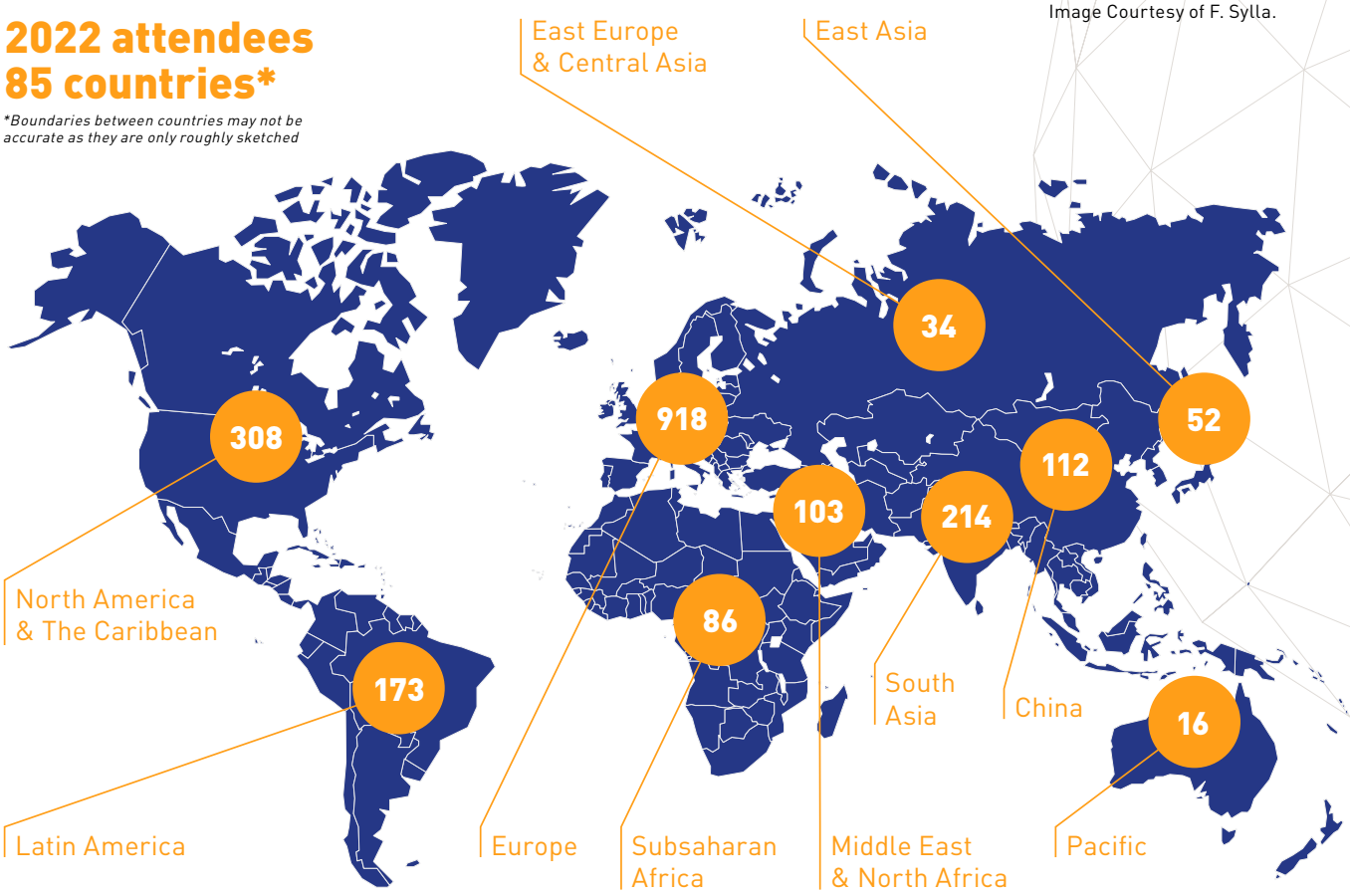
List of ROC&TOK webinars offered from Nov 2020 to July 2021. Table courtesy of F. Sylla.

The webinars target professors and senior PhDs. However, they are open to all interested, including students and those working in industry. The graph on the right shows the age range of the participants.

Participants have registered from all over the world, as shown in the graph below. Professional engineers that attend these webinars can apply to receive Continuing Professional Development (CPD) credits. The CPD credits are provided by the Institute of Concrete Technology, RILEM Partner since 2020.



Participation by age. People under 35 represent 65% of the attendants. Image Courtesy of F. Sylla.



Countries of origin of the attendants of the ROC&TOK webinars. Image courtesy of F. Sylla.

Each webinar is recorded and posted on the RILEM YouTube Channel where it can be watched for free. Each webinar posted so far has been watched by more than 500 viewers!

The webinars are moderated by Prof. Karen Scrivener, Chair of EAC. The technical support is given by Fanta Sylla, EAC secretary.

Recently closed TCs

In the last 12 months, the TCs presented 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
256-SPF	Spalling of concrete due to fire: testing and modelling	Pierre PIMIENTA	Robert JANSSON MC NAMEE	2013	Fall 2020
258-AAA	Avoiding alkali aggregate reactions in concrete - performance based concept	Børge J. WIGUM	Jan LINDGARD	2014	Fall 2020
260-RSC	Recommendations for use of superabsorbent polymers in concrete construction	Viktor MECHTCHERINE	Mateusz WYRZYKOWSKI	2014	Spring 2021
276-DFC	Digital fabrication with cement-based materials	Nicolas ROUSSEL	Dirk LOWKE	2016	Spring 2021

More details of these recently closed TCs can be found in the previous editions of the RILEM Technical Report or by visiting the page "Index of past TCs" on our website. A short summary of the activities in the last 12 months of these TCs is presented in the following lines.

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

- TC outcomes presented at the 74th RILEM Annual Week in September 2020. The recording of the presentation is available for free on the RILEM YouTube channel.
- Recommendations on screening and full-scale spalling test methods in preparation.
- STAR on concrete spalling under fire in progress.
- A follow-up TC proposal is coming.

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

- TC outcomes presented at the 74th RILEM Annual Week in September 2020. The recording of the presentation is available for free on the RILEM YouTube channel.
- The TC is in the progress of completing recommendations and a comprehensive "State-of-the-art" Report.
- 2 follow-up TCs have been approved: ASR & ARM

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

- V. Mechtcherine *et al.* Application of super absorbent polymers (SAP) in concrete construction—update of RILEM state-of-the-art report. *Mater Struct* **54**, 80 (2021).
- Interlaboratory study on the verification of the presence of superabsorbent polymer (SAP) in as-delivered mineral-based building materials.
- In progress: one report paper and one recommendation (verification of the presence of superabsorbent polymer in as-delivered mineral-based building materials), both to be submitted to *Materials and Structures* before end of 2021.

276-DFC Digital fabrication with cement-based materials
- STAR publication planned for Summer 2021
- 2 follow-up TCs have been approved: ADC & PFC

Here also come the publications of some TCs closed between Fall 2019 and Spring 2020 that have been released in the last 12 months.

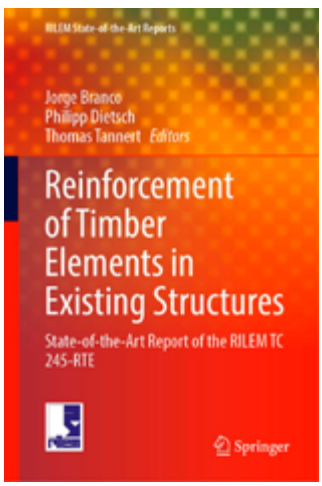
245-RTE: Reinforcement of timber elements in existing structures
Chair: Jorge BRANCO, Deputy Chair: Philipp DIETSCH
- STAR 245-RTE, Reinforcement of Timber Elements in Existing Structures, Edited by J. M. Branco, P. Dietsch and T. Tannert - Report Volume 33 published by Springer.

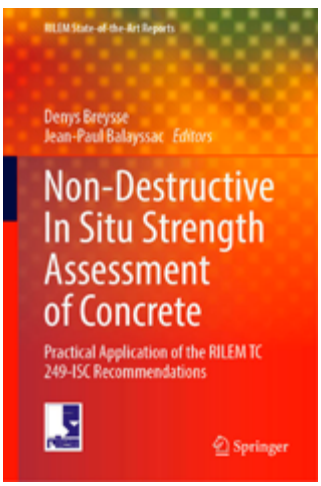
247-DTA: Durability testing of alkali-activated materials
Chair: John L. PROVIS, Deputy Chair: Frank WINNEFELD
- TC report: F. Winnefeld et al. RILEM TC 247-DTA round robin test: sulfate resistance, alkali-silica reaction and freeze–thaw resistance of alkali-activated concretes. *Mater Struct* **53**, 140 (2020).

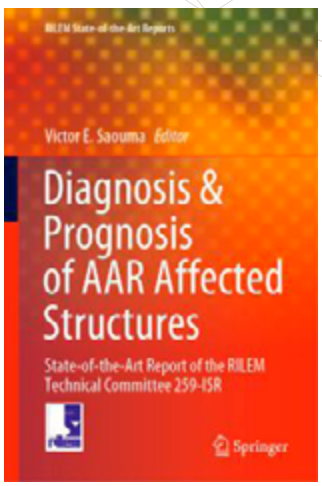
249-ISC: Non-destructive in-situ strength assessment of concrete
Chair: Denys BREYSSE, Deputy Chair: Jean-Paul BALAYSSAC
- STAR 249-ISC Non-destructive in situ strength assessment of concrete, Edited by D. Breysse and JP. Balayssac - Report Volume 33 published by Springer.

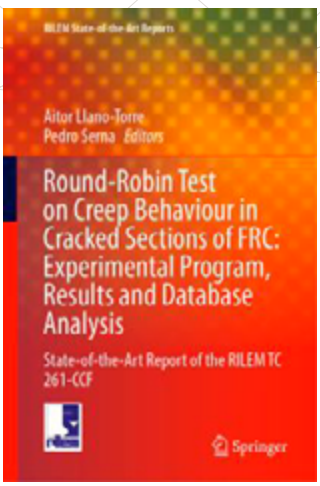
259-ISR: Prognosis of deterioration and loss of serviceability in structures affected by alkali-silica reaction
Chair: Victor SAOUMA, Deputy Chair: Leandro SANCHEZ
- STAR 259-ISR, Diagnosis and Prognosis of Alkali Aggregate Reactions Affected Structures, Edited by V. Saouma - Reportt Volume 31 published by Springer
- TC outcomes presented at the 74th RILEM Annual Week in September 2020. The recording of the presentation is available for free on the RILEM YouTube channel.

261-CCF: Creep behaviour in cracked sections of fibre reinforced concrete
Chair: Pedro SERNA, Deputy Chair: Sergio CAVALARO
- TC outcomes presented at the 74th RILEM Annual Week in September 2020. The recording of the presentation is available for free on the RILEM YouTube channel.
- A. Llano-Torre and P. Serna, Recommendation of RILEM TC 261-CCF: test method to determine the flexural creep of fibre reinforced concrete in the cracked state. *Mater Struct* **54**, 124 (2021). OPEN ACCESS!
- STAR 261-CCF, Round-Robin Test on Creep Behaviour in Cracked Sections of FRC: Experimental Program, Results and Database Analysis, Edited by A. Llano-Torre and P. Serna- Report Volume 34 published by Springer.









Cluster A
Material Processing and Characterization

Foreword
• from Cluster A Convener, Daman K. PANESAR

There are currently ten 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: rheology 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-HBD); properties of calcined clay (TC 282-CCL); reactive MgO-based expansive agents to reduce the risk of crack formation (TC 284-CEC); use of agro-based materials as cementitious additions in concrete and cement-based materials (TC 291-AMC); carbon based nanomaterials for multifunctional cementitious matrices (TC CNC); assessment of electrical materials to study corrosion of steel in concrete (TC ECS); assessment of additively manufactured concrete materials and structures (TC ADC) and performance requirements and testing of fresh printable cement-based materials (TC PFC).

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.

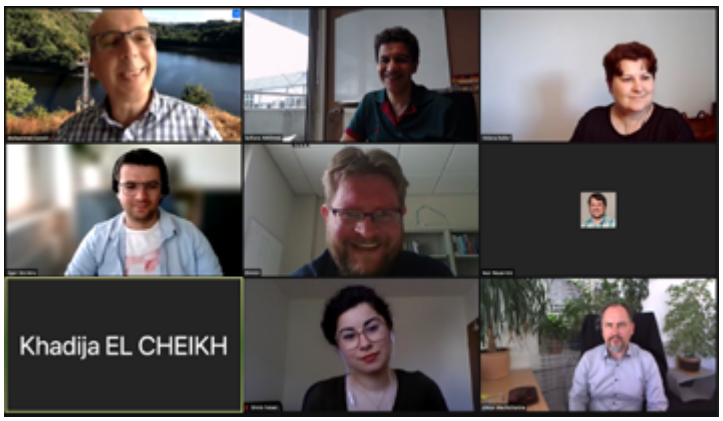
I have had the honour to serve on the RILEM Technical Activities Committee (TAC) since 2018 and have been the Convenor of Cluster A since 2019, previously held by Professor Barzin Mobasher.

Current TCs in Cluster A

Code	Title	Chair	Deputy Chair	TC opened in
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
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
291-AMC	Use of Agro-Based Materials as Cementitious Additions in Concrete and Cement-Based Materials	Said KENAI	Mike B. OTIENO	2018
ECS	Assessment of electrochemical methods to study corrosion of steel in concrete	Sylvia KESSLER	Ueli ANGST	2020 **NEW!**
ADC	Assessment of Additively Manufactured Concrete Materials and Structures	Viktor MECHTCHERINE	Freek BOS	2021 **NEW!**
PFC	Performance requirements and testing of fresh printable cement-based materials	Nicolas ROUSSEL	Dirk LOWKE	2021 **NEW!**
CNC	Carbon-based nanomaterials for multifunctional cementitious matrices	Florence SANCHEZ	Marco LIEBSCHER	2021 **NEW!**

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

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



Screen shot of a virtual meeting of RILEM TC 266-MRP. Image courtesy of D. Feys.

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

- Anticipated closure of TC was in Sept 2020. After 1-year extension has been approved, expected closure of TC is in Sept 2021.
- STAR expected to be finalised and reviewed by TC members in 2021.
- Three General Committee meetings held in 2020 (in March, in June and September).
- Five Concrete Rheometer Round Robin discussion meetings held in 2020 (in January, February, June, July and August).
- Presentation of TC outcomes planned in September 2021 at the 75th RILEM Annual Week.
- The laboratory work has been finalised.
- Several publications are in preparation.

267-TRM | Tests for reactivity of supplementary cementitious materials

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

Screen shot of the last virtual meeting of TC 267-TRM. Image courtesy of R. Snellings.

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

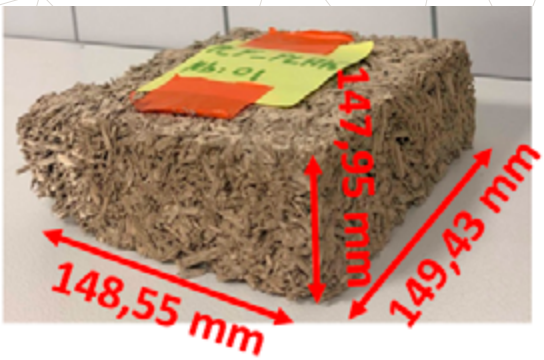
- Phase 1 (2016-2017): Comparison and benchmarking of SCM reactivity tests.
- Phase 2 (2017-2018): Optimisation of most promising test methods.
- Phase 3 (2019-2021): Validation and definition of scope of optimized finalized test protocols.

Progress

- ASTM C1897-20: Standard test methods for measuring the reactivity of supplementary cementitious materials by isothermal calorimetry and bound water measurements.
- 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). RILEM Technical Letter.
- Scrivener K. (2020) Outcomes of RILEM TC 267-TRM: Tests for Reactivity of Supplementary Cementitious Materials. Presentation at the 74th RILEM Annual Week, Sheffield, UK.
- Londono-Zuluaga et al. (2021) RILEM TC 267-TRM Report: Optimisation of the R3 reactivity Test. CoMS 2021 conference.
- Last meetings: 26/8/2020: 10th TC 267 TRM meeting – virtual; 23/3/2021: 11th TC 267 TRM meeting -virtual.
- TC reaching its closure by the end of this year. Final TC (social) meeting planned in occasion of the 2022 RILEM Spring Convention in Paris, France.

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

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



Preparation of sample of hemp fibre for the "cup method" ISO, 12572 ,2016. Image courtesy of F. Collet.

ICBBM Barcelona 2021 – RILEM Conference organized by the chair of TC 275 – 180 persons attended in hybrid format. Image courtesy of S. Ouldboukhitine.

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

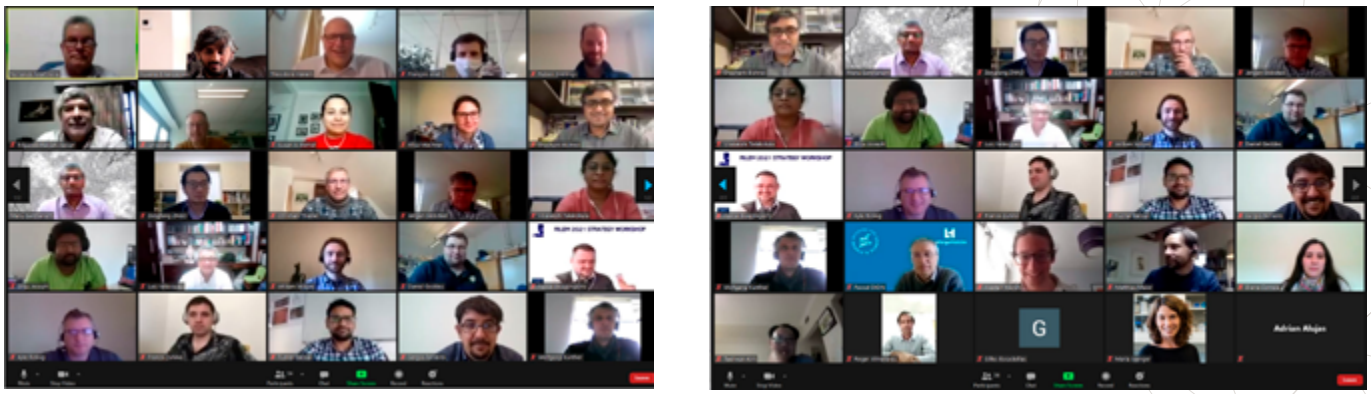
The RRT to compare the protocols in use by the different laboratories to measure density of specimens, thermal conductivity, Moisture Buffering Value (MBV) and water vapour transfer parameter parameters are in progress.

Progress

• 4 online meetings held between October 2020 and March 2021.
• Some delay experienced due to COVID pandemic. Additional year granted by TAC to complete TC work. TC closure expected in Nov 2022.
• First Round Robin Test (RRT) on Moisture Buffering Value (MBV) and Water Vapour Permeability (WVP) is finalised; 2nd RRT is planned to start soon.
• RILEM Recommendations will be published based on RRT results.
• TC outcomes will be presented at the RILEM Annual Week in 2022.

282-CCL | Calcined clays as supplementary cementitious Materials

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



Online meeting of TC 282-CCL held in April 2021. Image courtesy of F. Martirena-Hernandez.

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.
- Five work groups (WGs) on: (i) Clay exploration, (ii) Processing, (iii) Hydration, (iv) Fresh and Hardened Properties, and (v) Durability of cementitious systems with calcined clays.

Progress

- After a flourishing period in 2019 characterised by excellent progress, the TC has experienced a slow down of activities in 2020 due to the pandemic.
- Despite the pandemic, online meetings were held on a regular base.
- Next TC meetings are scheduled during the 75th RILEM Annual Week in September 2021 and at the 4th International Conference on Calcined Clays in April 2022.
- The following papers have been prepared by the different work groups:
  a. Properties and occurrence of clay resources for use as supplementary cementitious materials, prepared by Work Group 1, Clay Exploration (in Final Circulation within TC)
  b. Clay Calcination Technology: State-of-the-Art Review by the RILEM TC 282-CCL, prepared by Work Group 2, Processing (under preparation)
  c. Review of Fresh Properties of Concrete Containing Calcined Clays, prepared by Work Group 4, Fresh and Hardened Properties (submitted to Materials and Structures)
  d. State of art on durability performance of concrete with binary and ternary blended cementitious systems including calcined clay, prepared by Work Group 5, Durability (under preparation – final stages).

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

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

Liwu Mo gives a presentation on MgO expansive additive and concrete based on the current preparation of the STAR in the 3rd meeting online. Image courtesy of Hua Li.

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

- A state-of-the-art report on properties of MgO concrete and its engineering applications is under preparation and planned to be completed in 2022.
- A RILEM PhD course was given during the International EuroTech - RILEM PhD course and Workshop held on 12-16 January 2020, in Haifa, Israel.
- The round-robin tests for reaction time and restraint expansion of MgO expansive additive are being carried out in several laboratories. The results will be collected and compared with the report present at the next annual TC meeting.

291-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

Screen shot of the TC meeting held in conjunction with the 1-dau RILEM conference on Materials and value chains for sustainable, inclusive, and resilient urbanisation in Africa. Image courtesy of K. A. Olonade and W. Schmidt.

Student workshop on concrete at the University of Lagos. Image courtesy of M. Otieno.

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

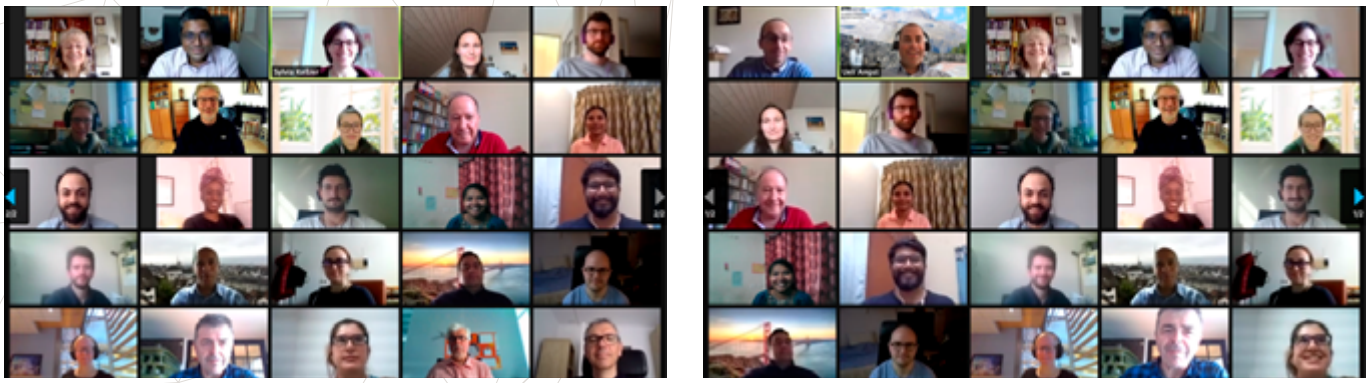
- Review available data and produce state of the art report on the use of agro-based materials in cement and concrete.
- Building a shared database on agro-based materials in developing countries.
- Publish recommendations on some of these materials.
- Perform Round Robin tests.

Progress

- Two online meetings held in Feb 2020 and January 2021.
- STAR expected to be finalised by December 2022.
- Preliminary TC outcomes presented online at the at the 1-day RILEM conference on “Materials and value chains for sustainable, inclusive, and resilient urbanisation in Africa”.
- Discussion is underway for Round Robin Testing.
- Envisaged mini-TC meeting in Accra, Ghana later in 2021
- Some delay experienced due to COVID-19.

ECS | Assessment of electrochemical methods to study corrosion of steel in concrete

Chair **Sylvia Kessler**
Deputy Chair **Ueli ANGST**
Activity started in 2020



Screenshots of the zoom videoconference of TC ECS. Picture courtesy of U. Angst.

Significance

Corrosion of steel in concrete is major reason for deterioration of concrete structures. The corrosion process of the reinforcement itself is of electrochemical nature. Therefore, electrochemical measurements are an essential tool in order to be able to assess and scientifically study the corrosion behaviour of metal-concrete-systems. Besides the assessment of the corrosion behaviour, electrochemical measurements form the basis to predict/ model the time of corrosion initiation and the propagation period.

Relevance

- The published reports will serve as recommendations for the application of electrochemical measurement methods in concrete.
- The recommendations will provide the basis for quality control of electrochemical data to assess the corrosion risk of steel/ metal interaction with concrete. Thus, industry and practitioners will benefit from these findings as well.

Goals

- State-of-the-art report addressing the influencing factors on performing electrochemical measurement of steel in concrete.
- Recommendations on how to prepare and perform an accurate measurement and on how to evaluate and post-process data from selected electrochemical test methods.
- Preparation of educational material on electrochemical measurements to study corrosion of steel in concrete.
- Organization of a summer school for graduate students researching in the field of corrosion of steel in concrete.
- Establishment of a network among the laboratories performing electrochemical measurements of steel in concrete.

Methodology

The methodology to establish an agreement on electrochemical techniques for the study of corrosion of steel in concrete includes the following steps:

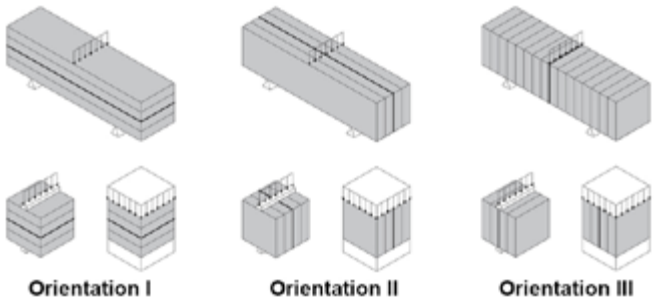
- discussing the setting parameters (including laboratory setup and specimen design),
- comparing the needed calibration measurement(s),
- agreeing on data representation and finally
- agreeing on data evaluation/ post-processing protocols.

Progress

RILEM TC ECS has been approved by the RILEM Technical Activities Committee (TAC) in fall 2020 and its kick-off meeting took place in February 2021.

ADC | Assessment of additively manufactured concrete materials and structures

Chair **Viktor MECHTCHERINE**
Deputy Chair **Freek BOS**
Activity started in 2021



Definition of orientation in printed concrete. Wolfs et al., 2019, doi: 10.1016/j.cemconres.2019.02.017.

3D concrete printed house. Image courtesy of B. van Overbeeke.

Significance

• Additive manufacturing (AM) of concrete structures is taking the world by storm due to its potentials of efficient use of materials, architectural freedom as well as high automation and productivity.
• The products made by AM typically show a considerable degree of anisotropy which can be traced back to the nature of their layer-by-layer manufacturing process.
• This and some other specifics of AM require a critical revisiting of all relevant test methods of materials characterisation towards establishing new, generally acceptable standards.

Relevance

The work of this TC will be of the utmost importance both for practical applications and further academic development of additive manufacturing with concrete. Thus, interest is expected from material suppliers, specialty producers, contractors, engineers and controlling authorities, as well as an increasingly large group academic researchers.

Goals

This TC intends to establish a set of recommendations on:
- Mechanical testing of printable and printed concrete,
- Estimation and characterisation of shrinkage and creep,
- Assessment of durability,
- Integration of reinforcement, particularly the testing of bond.

In addition, the TC will co-sponsor the Digital Concrete conferences.

Methodology

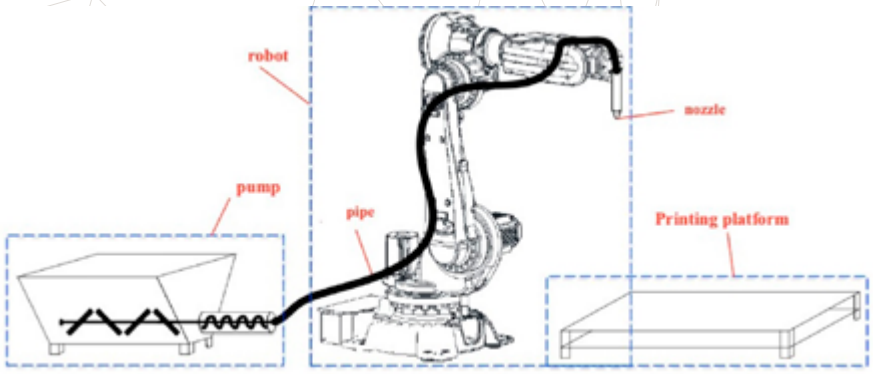
The work will concentrate on the mechanical properties of printed concrete in the hardening and hardened states which are relevant to structural behaviour, such as compressive and tensile strengths, modulus of elasticity, creep and shrinkage coefficients, and so on. The TC will:
- Collect and analyse available data,
- Initiate joint research efforts, such as interlaboratory studies and round-robin tests,
- Publish joint papers and recommendations.

Progress

This TC is a sister of the TC PFC, both of which follow up on the work of the previous TC 276. It was installed during the RILEM Spring Convention 2021, and held its kick-off meeting in the same week. We are currently preparing initial actions.

PFC | Performance requirements and testing of fresh printable cement-based materials

Chair **Nicolas ROUSSEL**
Deputy Chair **Dirk LOWKE**
Activity started in 2021



Layout of a 3DCP system. Image courtesy of TC PFC.

Significance

• 3DCP (3D Concrete Printing) is an Additive Manufacturing process.
• The geometric quality of manufactured parts is not only affected by the precision of the printing but also by the deformation under self-weight during manufacture.
• The time dependent characteristics of cement hydration and hardening plays a significant role in the performance of the resultant material and printed element.
• Being able to measure, assess and benchmark process and material performance using standardised and internationally accepted approaches is therefore essential for the industrial future of the technology.

Relevance

• The digital concrete fabrication offers new possibilities with regard to increasing productivity for concrete construction and enhancing its flexibility and sustainability. A considerable economic impact can be expected due to the benefits connected with its industrial utilization.
• The targeted users are researchers, practitioners and standardization bodies in the field of concrete technology.
• Practitioners are envisaged to implement the recommendations of this TC in their respective countries until the adoption of national or international standards.

Goals

• This TC will tackle three main topics: 1) Performance specification of the fresh properties of printable materials; 2) Measurement of the fresh properties of printable materials; 3) Evaluation of delivery system performance.
• The outcomes will be methods of performance assessment, measurement and specification that can be used to establish quality control for printing systems and materials for industrial application.
• This TC aims to produce the following outcomes: Recommendations for the practitioner; Reports on results of round-robin tests; International RILEM conferences incl. proceedings; RILEM PhD courses; Joint publications by TC members.

Methodology

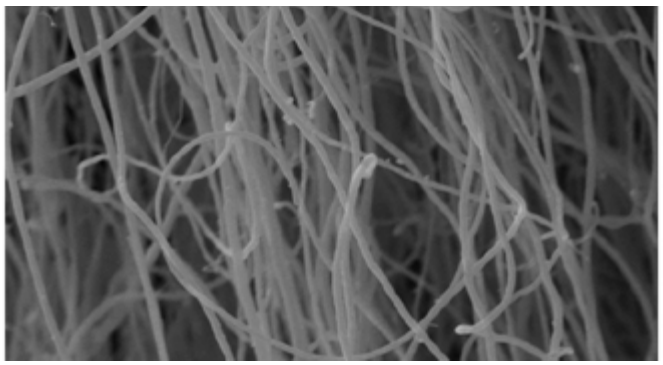
• The working program will include literature reviews, round-robin tests and other activities related to preparation of the above listed deliverables.
• Activities of the committee will include (co-)organizing international RILEM conferences on digital concrete construction.
• This TC is organised in 3 Technical groups:
  o Performance specifications of the fresh properties of printable materials
  o Measurement of the fresh properties of printable materials
  o Evaluation of delivery system performance.

Progress

• The proposed TC is a follow-up of TC 276-DFC "Digital fabrication with cement-based materials" lead by Prof. N. Roussel.
• TC PFC has been approved by TAC during the 2021 RILEM Spring convention on the 7th of April 2021 and has had its first online meeting on the 9th of April 2021.

CNC | Carbon-based nanomaterials for multifunctional cementitious matrices

Chair **Florence SANCHEZ**
Deputy Chair **Marco LIEBSCHER**
Activity started in 2021



Electron micrograph of entangled Multi-Walled Carbon Nanotubes. Courtesy of M. Liebscher, TU Dresden.

Screenshot of the meeting held in preparation of the proposal for TC CNC. Image courtesy of TC CNC.

Significance

Carbon-based nanomaterials - such as graphene, carbon nanotubes or carbon black - have gained recently a significant interest in research and development for civil engineering applications. When successfully dispersed in cementitious matrices, they have shown to improve strength, ductility, and fracture resistance; reduce cracking; decrease permeability; and increase durability, while providing innovative properties such as electrical and thermal conductivity. However, despite a large number of research activities, the application of nanocarbon modified cementitious matrices in concrete construction remains to date limited in part due to challenges related with scale-up implementations and a lack of a clear understanding of usually multiple, overlapping mechanisms.

Relevance

The TC will provide a much needed balanced view on nanocarbon modified cementitious matrices. It is expected to elucidate successful approaches to incorporate various carbon-based nanomaterials to enhance the durability and mechanical properties of cementitious matrices and to make them more sustainable and with multiple smart properties. The TC is of relevance for industry and research partners focusing on materials production and supply as well as smart sensing technologies.

Goals

- To perform a comprehensive and critical review of the existing literature with a state-of-the-art report on investigations and field applications of carbon-based nanomaterials in cementitious matrices.
- To exchange and disseminate knowledge through the organization of an international workshop on carbon-based nanomaterials in cementitious matrices.
- To provide technical guidelines/recommendations for designing cementitious composites with carbon-based nanomaterials and help implementation of nanocarbon modified cementitious matrices in concrete construction.

Methodology

- Establishment of three working groups on:
  A) Fresh properties (dispersion and rheology of carbon-based nanomaterials in aqueous solutions and cementitious matrices)
  B) Hardened state properties (mechanical, transport, and durability properties of nanocarbon modified cementitious matrices)
  C) Smart properties (electrical, self-sensing and other functional properties of nanocarbon modified cementitious matrices)
- Evaluation of the state-of-the-art knowledge and research data and continuous discussions in regular online and in-person meetings.

Progress

The TC was approved by the RILEM board during the spring meeting 2021. A Kick-off meeting for the TC is planned to be held in September 2021.

Cluster B
Transport and Deterioration Mechanisms

Foreword

- from Cluster B Convener,
  Josee DUCHESNE

I am delighted to be the new Cluster B Convener of RILEM. I have taken over from Esperanza Menendez Mendez, Cluster B convener from 2015 to 2020.

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.

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.

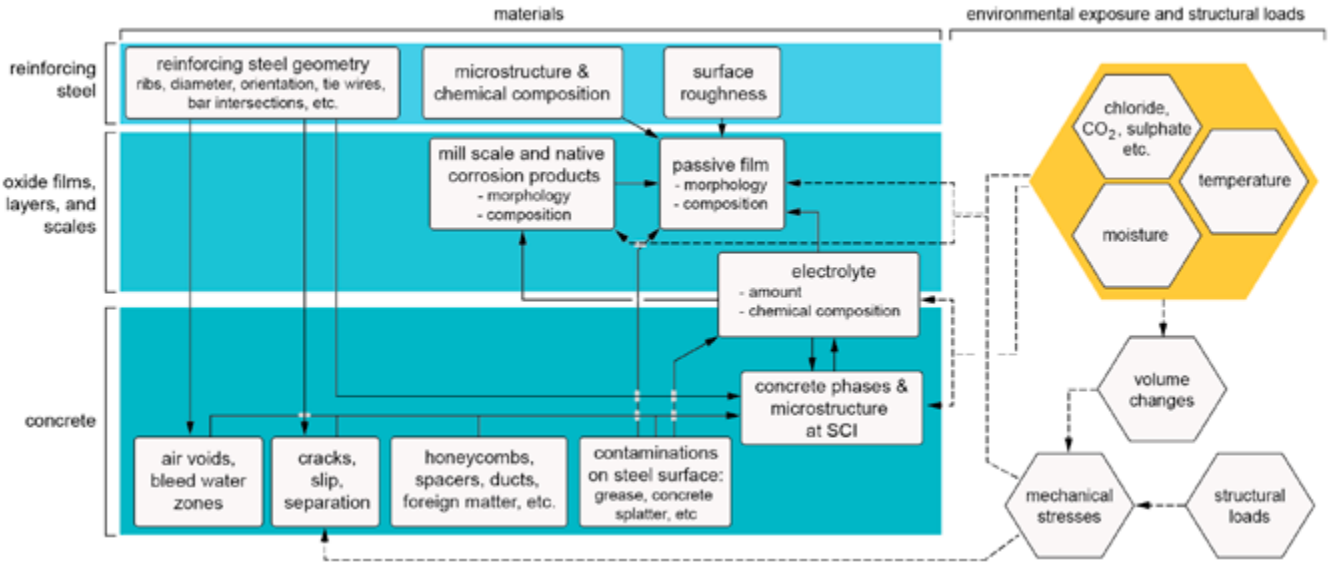
Between 2005 and 2021, 24 Technical Committees have been created under Cluster B. Currently, Cluster B has 8 active TCs. These TCs are related with different aspects of traditional and novel construction materials, their properties, and the durability behaviour. With respect to the production of these TCs, around 15 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	2014
281-CCC	Carbonation of concrete with supplementary cementitious materials	Nele DE BELIE	Susan BERNAL LOPEZ	2017
283-CAM	Chloride transport in alkali-activated materials	Arnaud CASTEL	Shishir MUNDRA	2018
285-TMS	Test method for concrete durability under combined role of sulphate and chloride ions	Changwen MIAO	Geert DE SCHUTTER	2018
286-GDP	Test Methods for Gas Diffusion in Porous Media	Bruno HUET	Philippe TURCRY	2019
DOC	Degradation of organic coating materials and its relation to concrete durability	Takafumi NOGUCHI	Kei-Ichi IMAMOTO	2020
EBD	Test methods to evaluate durability of blended cement pastes against deleterious ions	William WILSON	Prannoy SURANENI	2020 **NEW!**
FTC	Durability and Service Life of Concrete under the Influence of Freeze-Thaw Cycles combined with Chloride Penetration	Erik SCHLANGEN	Peng ZHANG	2018

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

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



Schematic illustration of interrelations between different characteristics at the steel-concrete interface and of influences by environmental exposure. U. Angst et al. Materials and Structures (2017) 50 :143.

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.

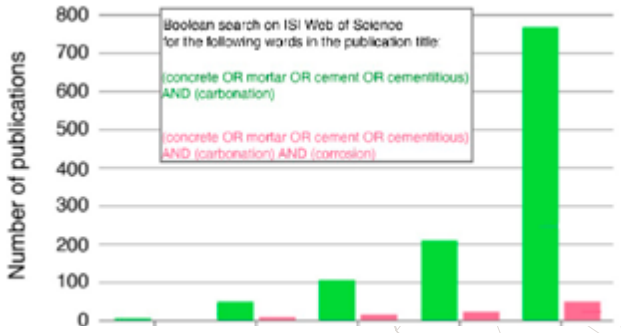
Progress

- From June 2015 to November 2020, 16 meetings have been held.
- Outcomes of TC were presented (online) at the 74th RILEM Annual Week in September 2020. The presentation is available on the RILEM YouTube Channel.
- TC 262-SCI is currently preparing a manuscript on methods to study the steel-concrete interface. A draft is ready. The work is expected to be completed in 2021.
- This TC is finalizing the last work package and will be closed within the coming 6 months.

281-CCC | Carbonation of concrete with supplementary cementitious materials

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

Alkali-activated slag concrete specimens after spraying with phenolphthalein to determine their initial carbonation depths. Image courtesy of BAM.



Research attention illustrated by a Boolean search on ISI Web of Science, revealing that by far most of the scientific literature regards carbonation of the concrete, while only relatively few studies addressed steel corrosion in carbonated concrete. Angst et al. (2020), RILEM Technical Letters, 50, 85-100).

Significance

SCM-containing concrete exhibits high carbonation susceptibility. As carbonation is believed to cause 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 for practitioners to determine service life of structures
- 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.

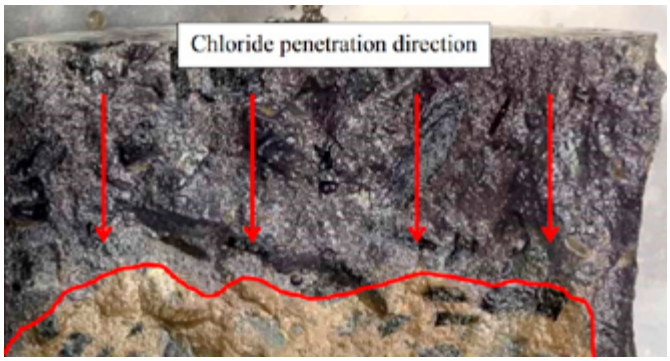
Progress

- Special session during the 74th RILEM Annual Week, August 2020, Sheffield (UK) (14 abstracts).
- "Overview RILEM TC 281 CCC - Carbonation of concrete with SCMs', invited talk at LatRILEM panel. La Plata, Argentina, November 2020
- "RILEM TC 281-CCC working group 6: Carbonation of alkali activated concrete – preliminary results of a literature survey and data analysis", abstract submitted to the 75th RILEM Annual Week 2021, Merida, Mexico, September 2021.
- "Understanding carbonation of Concrete with Supplementary Cementitious Materials – A Review". Materials and Structures. 53, 136 (2020). Winner of one of the Outstanding 2020 Paper Awards granted by the Materials and Structures journal
- "Corrosion of steel in carbonated concrete: mechanisms, practical experience, and research priorities – a critical review by RILEM TC 281-CCC". RILEM Technical Letters. 50, 85-100 (2020)
- "Critical review of standardised test methods to determine carbonation resistance of concrete with supplementary cementitious materials". Paper to be submitted to Materials and Structures in July 2021.
- "Accelerated carbonation testing of mortars and concretes with SCMs – outcomes of an interlaboratory test". Paper to be submitted to Materials and Structures in July 2021.

283-CAM | Chloride transport in alkali-activated materials

Chair **Arnaud CASTEL**
Deputy Chair **Shishir MUNDRA**
Activity started in 2018

Port Macquarie boat ramp, NSW Australia. Picture courtesy of A. Castel.



Chloride penetration depth measurement after conducting the chloride migration test NT Build 492. A. Noushini et al. Materials and Structures (2021) 54:57.

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

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

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 (ionexchange, 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

• TC meeting held online alongside the conference MATBUD in Krakow, Ponland, in October 2020: experimental protocols for both WG1 and WG2 were finalised amongst members of the committee.
• TC meeting held online alongside RILEM Spring Convention in April 2021: Several research groups have shown interest in carrying out WG1 and WG2 experiments and the results of which are due before TC CAM committee meeting in the first quarter of 2022.
• Second field specimens will be collected in 2021 from Port Macquarie boat ramp (NSW, Australia) after 3 years of exposure.
• An assessment of chloride binding in GGBS based AAMs and synthetic phases formed in these AAMs are currently ongoing in BAM (Germany), Univeristy of Bologna (Italy) and ETH Zurich (Switzerland).

285-TMS | Test method for concrete durability under combined role of sulphate and chloride ions

Chair **Changwen MIAO**
Deputy Chair **Geert DE SCHUTTER**
Activity started in 2018

Qinghai saline soil environment: dry and strong wind, high salt content in the soil. Picture Courtesy of Dr Mu Song.

Simulation of ry and strong wind environment. Courtesy of Xie Deqing.

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

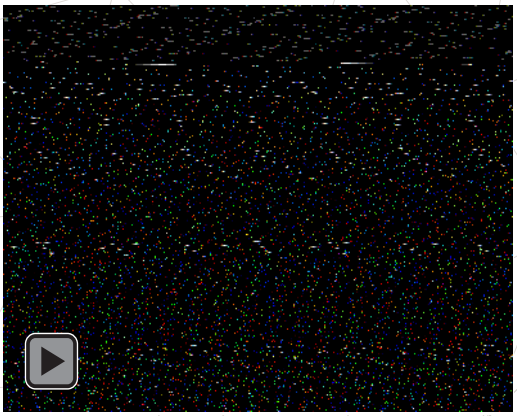
• Literature review on degradation mechanisms.
• Experimental programs for testing chloride penetration in presence of sulphate ions.
• Comparative test series to observe combined sulphate and chloride migration into concrete.
• Evaluation and discussion of test results and necessary improvement of the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

Progress

• Revised report on the state of the art on test methods of sulphate attack and chloride transport.
• Investigation on the experimental methods and performance indicators of concrete specimens considering a coupling effect of sulfate and chloride ions under the role of dry-wet cycles and half-buried environments.
• Performance evaluation on concrete specimens exposed to saline soil environment and indoor simulation experiment.

286-GDP | Test methods for gas diffusion in porous media

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



Comparison of numerical and experimental data about O2 concentration in porous cementitious materials. Image courtesy of B. Huet.

Gas diffusion cell. Image courtesy of Imperial College, UK.

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

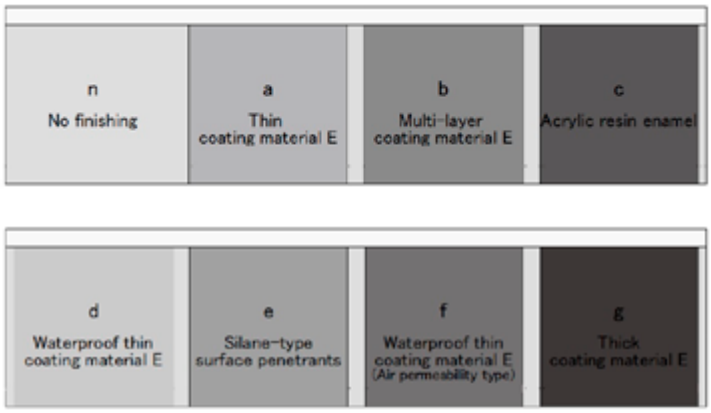
- Collecting information on existing gas diffusion tests and state of the art review.
- Proposal of a benchmark of methods on reference inert materials and non-ageing cementitious materials is proposed.
- Assessing the effect of low pressure difference gradient for each test method, resulting from the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

Progress

- Presentation of the TC GDP activity at the 74th RILEM Annual Week in August 2020.
- Benchmark meeting during RILEM Spring Convention in April 2021.
- STAR, with 9 chapters, under preparation.
- Papers on benchmark: experimental aspects and calculation aspects.
- About 600 diffusion tests, 7 labs, 4 materials currently tested (and one more to come) spanning the range of diffusivity from 10-10 to 4.0 10-7 m2.s-1.
- Statistical analysis (on-going) has already shown some systematic errors between labs but good repeatability and reproducibility within labs.

DOC | Degradation of organic coating materials and its relation to concrete durability

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



Experimental campaign to measure the durability of concrete panels coated with different finishing materials. Image 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.

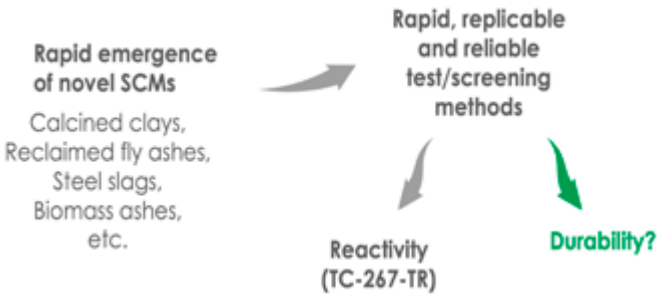
Progress

• Kick off online meeting held in March 2021.
• A special session on “Degradation of organic coating materials and its relation to concrete durability” was successfully held at the XV DBMC 2020.
• Round robin test working plan to be scheduled soon.

EBD | Test methods to evaluate durability of blended cement pastes against deleterious ions

Chair **William WILSON**
Deputy Chair **Prannoy SURANENI**
ctivity started in 2020

TC EBD members at the second online TC meeting. Picture courtesy of William Wilson.



Context and background of TC EBD. Picture courtesy of William Wilson.

Significance

The CO_2 reduction targets of the cement industry necessitate the development of local alternative supplementary cementitious materials (SCMs) to reduce the global clinker factor of cements. The adoption of novel SCMs requires efficient and reliable test methods to investigate the effect of SCMs not only in terms of reactivity but also on long-term concrete durability.

Relevance

- Researchers interested in fundamental understanding of paste durability testing.
- Supplementary cementitious material suppliers and concrete industry to test and use new sources of SCMs.
- Standardisation committees to incorporate the durability testing of SCMs, cements, and cement pastes.
- Practitioners involved in projects requiring new blended-cement systems.

Goals

- Evaluate test methods at the scale of the cement paste to quantify the effects of new SCMs on the durability against deleterious ions (chloride ingress and sulfate attack).
- Provide recommendations and educational material to foster the use of the most promising test method.

Methodology

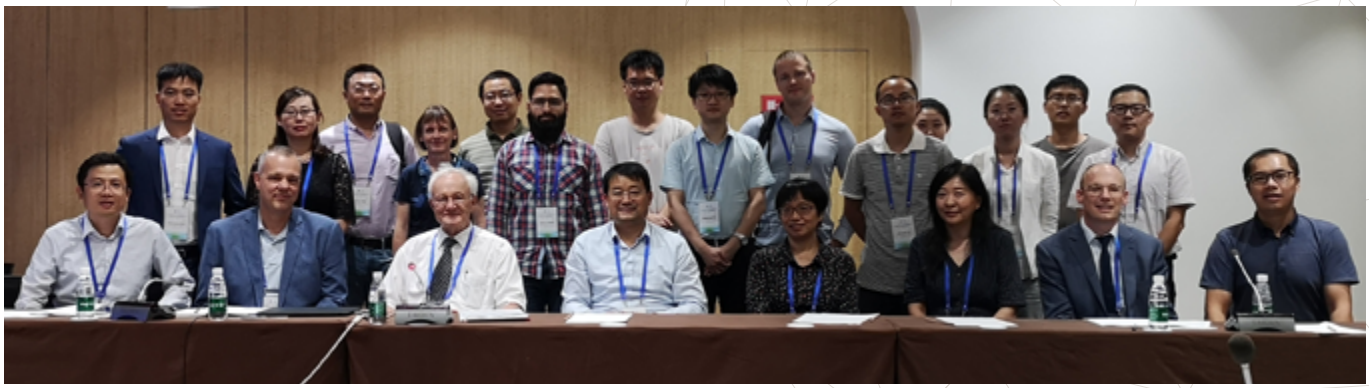
- Literature review to obtain a consensus on existing approaches, terminology and directions for the experimental testing by TC EBD.
- Robustness and round-robin type testing of promising experimental methods for chloride ingress and sulfate attack in cement pastes.
- Comparison of test results with cement mortar/concrete test results.
- Publication of findings, recommendations, and educational material.

Progress

- Online meetings to kick-off the TC, then to share expertise and visions on challenges and opportunities for TC EBD.
- Ongoing review of existing test methods in subgroups focusing on: microstructure, reactions with chlorides, reactions with sulfates and transport.

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

Chair **Erik SCHLANGEN**
Deputy Chair **Peng ZHANG**
Activity started in 2018



First TC meeting during the 73rd RILEM Annual Week in 2019 in Nanjing, China. Picture courtesy of E. Schlangen.

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 have started shall be run in a number of laboratories in different countries. Results shall be compared and critically discussed.

Progress

• A comprehensive literature review has been published: Durability and Service Life of Concrete Under the Influence of Freeze-Thaw Cycles Combined with Chloride Penetration - An Annotated Bibliography, P. Zhang, F. Wittmann, J. Bao and Y. Cui Editors. 2020 Aedificatio Publishers. ISBN 978-3-942052-10-8. DOI 10.12900/B20-0002
• In the online TC meeting in April 2021 the first results of the comparative test series were discussed. The guidelines for the test series were specified in more details and more labs promised to start the test series soon.
• It was decided to perform simulation exercises of the specimens and conditions tested in the comparative test series. The simulation results will provide an extra dataset that will be added to the experimental results.

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 six TCs are active in impact and explosion (288-IEC), damage assessment in consideration of repair-retrofit-recovery (269-IAM), structural behaviour of recycled aggregate concrete (273-RAC), crack width analysis (287-CCS), textile rein¬forced concrete (292-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
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
287-CCS	Early age and long-term crack width analysis in RC Structures	Miguel Ângelo Dias AZENHA	Fragkoulis KANAVARIS	2019
288-IEC	Impact and Explosion	Marco DI PRISCO	Ezio CADONI	2018
292-MCC	Mechanical Characterization and Structural design of Textile Reinforced Concrete	Barzin MOBASHER	Flávio DE ANDRADE SILVA	2019
MPA	Mechanical properties of alkali-activated concrete	Guang YE	Frank DEHN	2019

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

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

8th digital TC meeting of 15th April 2021.
Image courtesy of D. Angelis.

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

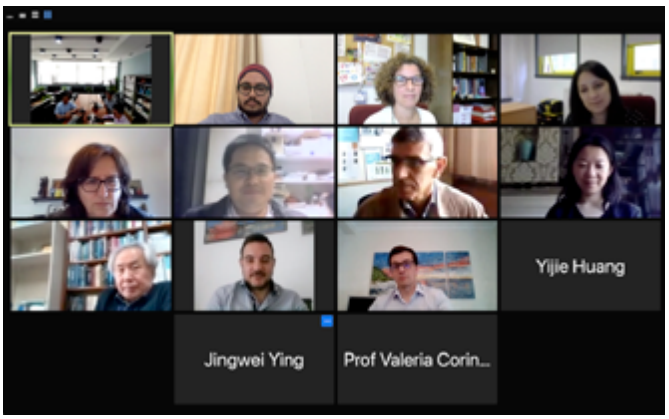
- Studies of repair practices in different countries.
- Organization of “task forces” focused on:
  1. Survey (suitable NDT methods).
  2. Evaluation of initial damage.
  3. Evaluation of repair.
  4. Life cycle management in relation to 3.

Progress

- Last (8th) TC meeting held on 15 April 2021.
- Assignment of chapters of STAR to TC members in progress.
- Draft of RILEM two-recommendation in progress.
- Relevant workshop will be organised during the 76th RILEM Annual Week in Kyoto, Japan, in Sep. 2022.

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

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



Screen shot at the last meeting of TC 273-RAC.
Image courtesy of S. Amardeep.

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

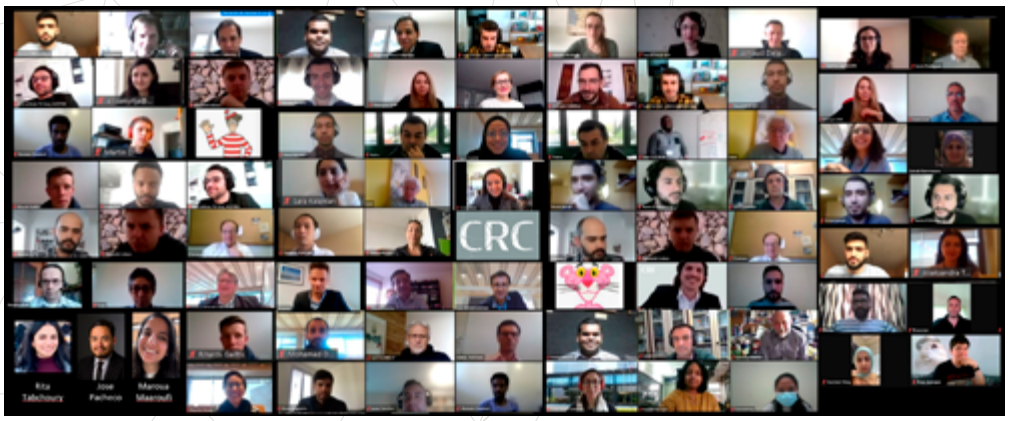
• To validate the RAC for structural purposes, by experiments and simulations and comparing them with the data for regular concrete and monitoring on-site.
• Performing tests to investigate the effect of RCA addition on mechanical behavior and long-term properties of RAC.
• Analyzing the existing standards and specifications of RA and RAC.

Progress

• TC 273-RAC, Part B - Report on Recycled Aggregate Concrete Structural performance is at final stage.
• An online meeting was held on May 7th, 2021. The main point on the agenda was the discussion of the finalization of the Technical Report of the TC. The above mentioned reports will be modified to incorporate the advice of the experts and then finalized for publication.

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

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



Snapshot of participants from RILEM CRC2021 conference. Image courtesy of Farid Benboudjema.

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".
• Contribute to the organisation and delivery of RILEM EAC course on early-age and long-term cracking in concrete.
• Establish leading edge guidance which will promote a more accurate and sustainable approach to control of cracking in reinforced concrete structures.

Methodology

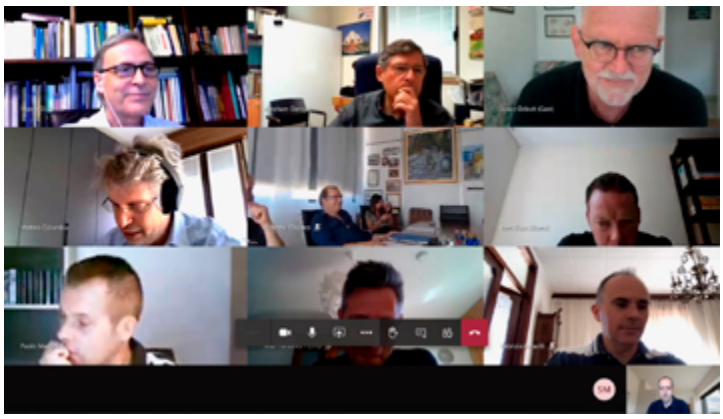
• Use of web platforms of conference calls to perform on-line meetings (roughly half of the meetings).
• Benchmarking of numerical and analytical models for crack width estimation.
• Bibliographical research and exchange of experience and results, including unpublished results.
• On-site monitoring of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

Progress

• 2 official videoconferencing meetings held in the last 12 months (in occasion of the 74th RILEM Annual Week and of the 4th RILEM Spring Convention) and several intermediate work group-specific meetings held.
• RILEM Recommendations on thermo-mechanical modelling of massive concrete structures has been submitted to Materials and Structures for publication.
• RILEM International Conference on Concrete Cracking (CRC2021) held as part of the RILEM 2021 Spring Convention in Paris on 09th April 2021 with approximately 210 participants. CRC2021 proceedings will be published by Springer.
• Contribution to the organisation and future delivery of RILEM EAC course on early-age and long-term cracking in concrete.
• The outline of a RILEM book on crack width analysis has been finalised and individual book chapters and being developed with a planned completion date within 2023.

288-IEC | Impact and explosion

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



Participants of the online meeting of TC 288-IEC.
Image 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

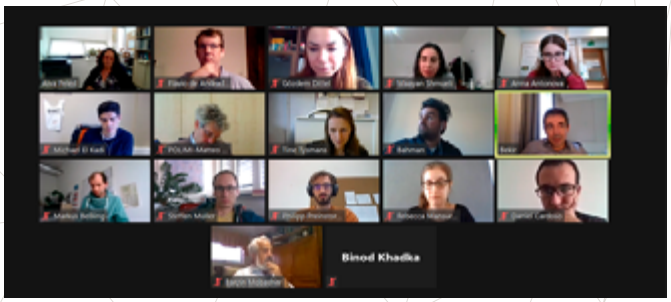
• The first database has been completed; the working group met in the occasion of the last RILEM/fib/ACI Workshop Protect 2019 in Vancouver and this year is working on the fib background document and the chapter 27 of the Model Code 2020.
• In the two following years, the Committee will achieve the last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

Progress

• Three TC meetings held in the last 12 months.
• A TC report on "Experimental devices harvest for impact and explosion testing of materials and structures" has been released in June 2020 and is available online free to be downloaded.
• First complete draft of Model Code 2020 presented in November to fib TG10.1 2020.

292-MCC | Mechanical characterization and structural design of textile reinforced concrete

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



Online meeting of working group one – April 19th 2021.
Image courtesy of TC MCC.

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.
• 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.
• A State-of-the-Art document address the recent developments in the past 15 years.
• The expected outcomes include to develop a set of recommendations and design guides.
• This TC plans to organise training courses for graduate students and researchers in the TRC area.
• Collaborations and Publication of standards and reports with ASTM, fib, and ACI as well as ISO.

Methodology

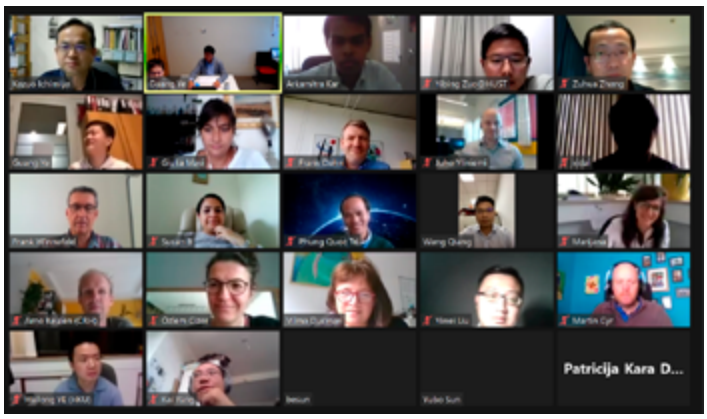
• Five working groups are currently in place:
WG 1–Materials and material systems (Chairs: Alva Peled and Flávio Silva)
WG 2 – Constitutive modelling (Chairs: Marco di Prisco and Matteo Colombo)
WG 3 – New Elements (Chairs: Rostislav Chudoba and Tine Tysmans)
WG 4 – Retrofitting (Chairs: Bahman Ghiassi and Manfred Curbach)
WG 5 – Durability and sustainability (Chairs: Viktor Mechtcherine and Martin Hunger)
• 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

Two hybrid TC meetings organised in 2021 in conjunction with 1) the 13th International Symposium on Ferrocement, Lyon, France, June 2021 and 2) RILEM Befib 2021, Spain, Valencia, September 2021.
TC Papers will be presented at the above-mentioned conferences.
The state-of-the-art-report – Draft Document to be ready by the end of July 2021.
Literature review papers – Draft of a literature review paper on sustainability (WG 5) of TRC is ready.
Several state-of-the-art sessions on textile-reinforced concrete/fabric-reinforced cementitious matrix (TRC/FRCM) were organized by ACI Committee 549 in collaboration with RILEM TC MCC during the ACI Fall 2019 Convention in Cincinnati, OH, and the ACI Virtual Technical Presentations in June 2020.
The papers at the above-mentioned sessions are available in: SP-345: Materials, Analysis, Structural Design and Applications of Textile Reinforced Concrete/Fabric Reinforced Cementitious Matrix, ACI Symposium Publication, Vol 345, ACI Committee 549- Rilem-MCC. Editors: Barzin Mobasher and Flávio de Andrade Silva (2021). The videos of the presentations are available here.

MPA | Mechanical properties of alkali-activated materials

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



Screen shot of online meeting of TC MPA.
Image courtesy of G. Ye.

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

- 71 TC members are active in this TC – 17 new members registered in the last 12 months.
- 3 online TC meetings have been held in the last 12 months.
- The table of content of the STAR is defined: Part I – chemistry and mix design; Part II – short and long term properties; Part III – volume stability and cracking potential.
- Round Robin Tests (RRTs) of mechanical properties of alkali-activated concrete have been planned and preliminary mix design has been studied by TU Delft and Antwerp University.

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 six 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, 25 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 re¬ports (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
270-CIM	Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice	Eddie A. B. KOENDERS	Kei-Ichi IMAMOTO	2016
289-DCM	Long-term durability of structural concretes in marine exposure conditions	Kefei LI	Junjie ZENG	2019
ARM	Alkali-aggregate reaction mitigation	Esperanza MENENDEZ MENDEZ	Leandro SANCHEZ	2020 **NEW!**
ASR	Risk assessment of concrete mixture designs with alkali-silica reactive (ASR) aggregates	Jason H. IDEKER	Klaartje DE WEERDT	2020 **NEW!**
293-CCH	Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete-Reinforcing Steels	Javier SANCHEZ MONTERO	Alvaro RIDRUEJO	2016
TES	Thermal energy storage in cementitious composites	Jorge Sánchez DOLADO	Antonio CAGGIANO	2020 **NEW!**

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

Concrete piers of the Swakopmund jetty in Namibia. Picture courtesy of Grant Durr.

Corrosion of steel bars in reinforced concrete. Image courtesy of the web.

Significance

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

Relevance

- A calibration tool for chloride ingress models enables engineers/consultants to assess the durability and service life of concrete structures more accurate and reliable.
- An enhanced 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 mid- and long-term maintenance predictions of concrete structures.

Goals

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

Methodology

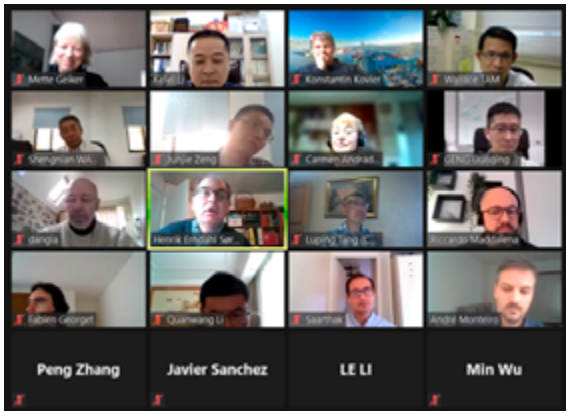
- Identifying currently available analytical and numerical models used for chloride ingress calculations.
- Selecting and defining two typical case studies to be employed for benchmarking.
- Simulating the chloride ingress for these two case studies with the analytical and numerical models and analyse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

Progress

- Four online TC meetings in the last 12 months, 2 in 2020 and 2 in 2021.
- The draft of the TC STAR is planned to be ready by July 2021.
- A paper to be submitted to Materials and Structures is planned for 2021.
- A presentation of the TC results is scheduled for the upcoming 75th RILEM Annual Week.

289-DCM | Long-term durability of structural concretes in marine exposure

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



TC members at the last online TC general meeting. Image courtesy of K. 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

• This TC started officially in June 2019. Soon after its official kick-off, the TC members were confined by COVID-19 situation. Regardless of this inconvenience, the TC continues to grow, accumulating nearly 40 members so far.
• One review paper is expected to be finished during 2021 and proposed for *Materials and Structures.*

ARM | Alkali-aggregate reaction mitigation

Chair **Esperanza MENENDEZ MENDEZ**
Deputy Chair **Leandro SANCHEZ**
Activity started in 2020

A concrete pylon damaged by alkali-aggregate reaction. Image courtesy of L. Sanchez.

Bridge support pillars repaired after being damaged by alkali-aggregated reaction. Image courtesy of L. Oliveira Santos.

Significance

• Alkali-aggregate reaction (AAR) is one of the most harmful distress mechanisms affecting the durability and serviceability of aging structures worldwide.
• Several approaches, recommendations, and test procedures have been developed to assess the potential alkali-reactivity of concrete aggregates and the efficiency of preventive measures prior to AAR development in the field.
• There is currently no consensus about the most efficient method(s) that should be implemented, and when, for the mitigation of AAR-induced development of affected structures/structural members. This situation is extremely critical for some structures whose AAR-associated risks are extremely high since they cannot be easily rehabilitated nor replaced such as dams, nuclear power plants, tunnels, bridges, etc.

Relevance

RILEM TC ARM is interesting for researchers working on internal swelling reaction mechanisms, more specific alkali-aggregate reaction, along with practitioners from governmental, crown or private companies dealing with critical aging concrete infrastructure.

Goals

• This TC aims to study alternative materials and strategies to mitigate alkali-aggregate reaction (AAR) and associated mechanisms (e.g., delayed ettringite formation – DEF, freeze-thaw – FT, etc.) in the laboratory and in the field.
• Comprehensive literature reviews illustrating advantages and drawbacks of a wide range of non-traditional materials and strategies will be conducted along with their evaluation in the laboratory.
• The committee anticipates being able to generate, at the end of its cycle, guidelines for researchers, engineers and infrastructure owners to better cope with deterioration cause by AAR and related mechanisms.

Methodology

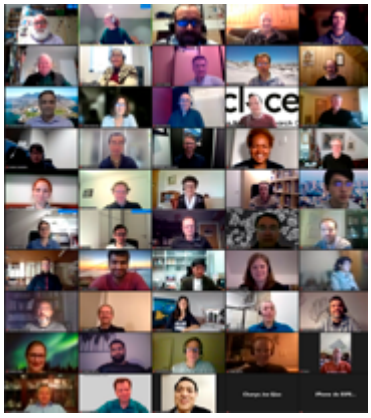
This TC will comprise three work package (WP) groups dealing with the following:
WP1: Actions to mitigate AAR in affected concrete structures.
• WP2: Non-traditional mitigation products in new and affected concrete.
• WP3: Test procedures and strategies to evaluate non-traditional mitigation products in new and affected concrete.
WP 1 will conduct a comprehensive literature review on strategies enabling AAR mitigation in the field. WP2 will develop an in-depth study of non-traditional materials that could be implemented in concrete (i.e., before or after AAR takes place) to mitigate AAR-induced expansion and deterioration. WP3 will appraise the performance of the non-traditional materials proposed by WP2 in the laboratory.

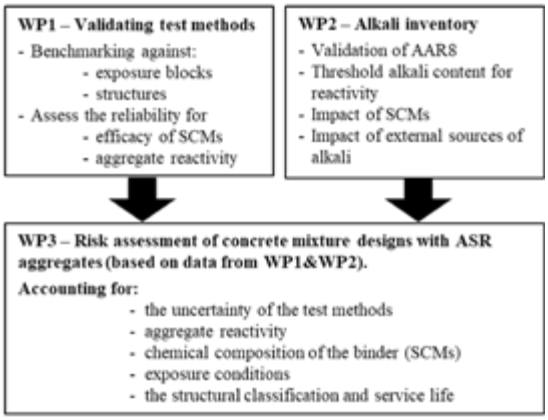
Progress

RILEM TC ARM has been approved by the RILEM in the fall 2020 and held its kick-off meeting in April 2021. The WPs will be scheduling the first meetings and activities over the summer 2021 and the second general meeting is scheduled for November 2021.

ASR | Risk assessment of concrete mixture designs with alkali-silica reactive (ASR) aggregates

Chair **Jason H. IDEKER**
Deputy Chair **Klaartje DE WEERDT**
Activity started in 2020





Left: Screen shot from the first digital TC ASR meeting held on the 6th of April. Picture courtesy of K. De Weerdt. Right: Structure of the TC ASR.

Significance

Alkali-silica reaction (ASR) is a well-known concrete durability problem. However, the industry needs clear guidance on how to design and specify concrete mixtures that are resistant to ASR. The TC will develop a framework for risk assessment of mixture designs for concrete prone to ASR. This framework would allow the user to determine a pathway for mixture designs with reduced risk for deleterious ASR.

Relevance

- The TC will provide information that is relevant to academics, testing laboratories, practitioners, Ph.D. students, government agencies, private industry and standards/code/specification organizations.
- The results from this TC will be used to improve existing concrete standards and specifications and to ensure new concrete is resistant to ASR.
- The results may ultimately inform a new way to design concrete mixtures to be ASR resistant and this may ultimately be placed into standards/codes/specifications.

Goals

- The goal of the proposed TC is to develop a framework for risk assessment of mixture design for concrete containing alkali silica-reactive aggregates.
- Central in such a framework is the determination of the uncertainty of the selected accelerated performance-based test methods by comparing to field performance, as well as systemizing the impact of different alkali sources on both reactivity and prevention.

Methodology

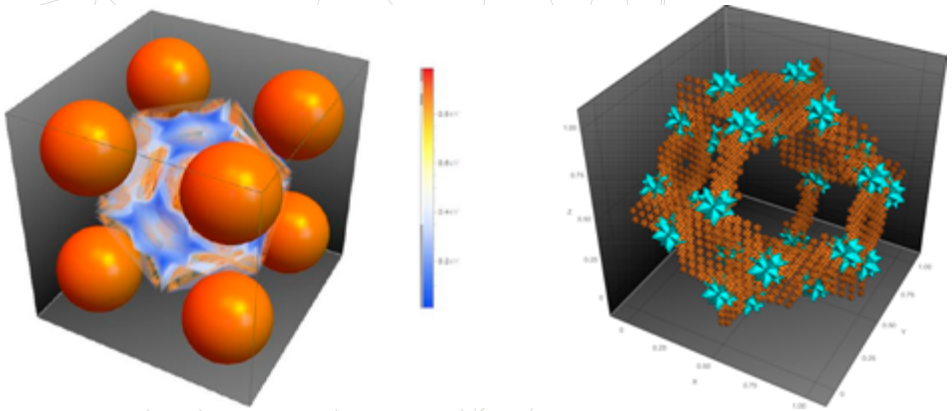
Each WP will facilitate small groups to collaborate, write and publish papers that provide critical insights into new data, analysis of existing data and research needs to address their goals. At the end of the TC an executive summary will establish the link between papers, highlighting main findings and future research needs and present the proposed framework in the form of a final report.

Progress

- Kick Off Meeting for TC ASR Leadership Team (WP Chairs and Co-Chairs) held in March 2021.
- Virtual meeting of entire TC and Work Packages held in April 2021.

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

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



Energy landscape for an isolated hydrogen atom within an iron lattice. Preferent diffusion paths and high-symmetry sites. Figure was obtained from first-principle simulations. Authors: J Sánchez, G. Álvarez, A. Ridruejo and P. de Andrés.

Significance

• Many structural components made of steel, including pretensioned and post-tensioned concrete structures fail due to stress corrosion cracking (SCC) and hydrogen embrittlement (HE).
• The coupled chemical, mechanical and physical mechanisms of SCC and HE have not been satisfactorily explained yet.
• Understanding the chemical and physical interactions involving crack propagation by SCC and hydrogen inside the iron lattice would help to understand, control, and prevent the catastrophic mechanical failure of steel.
• There is no general agreement on testing methods for the study of SCC. The current knowledge of these phenomena in certain environments, such as low-oxygen atmospheres, is restricted to experts. Industry can benefit from an enhanced transference of know-how from the scientific community.
• Over the last years, the advent of new modelling tools, in particular Multiphysics and phase field techniques, have greatly boosted the predictive power of computer simulations. Making these tools accessible to a wider audience will reduce cost and improve the safety of many structural components.

Relevance

• The targeted group of users is primarily researchers and experts from academia and industry
• The outcomes of this TC will also be useful for consulting engineers to design, 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 or post-tensioned structures.
• The report will provide assessment and mitigation methods for SCC and HE. The report will also include recommendations regarding testing parameters and procedures, as well as simulation techniques which allow engineers to monitor, control or model the evolution of SCC-related processes in real structures.
• The report also encompasses case studies of structural failure caused by HE or SCC.

Methodology

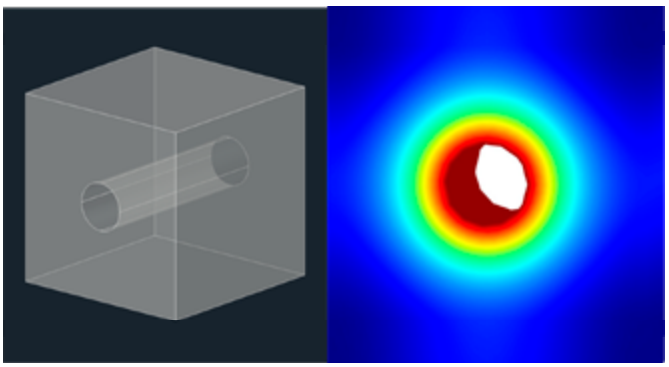
• Collection of documented results from the literature.
• Developing theoretical and conceptual reasoning within the committee.
• Exchange of experience and results, including unpublished ones, between TC members.
• Organization of workshops with invited presentations on selected topics to stimulate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

Progress

• During last year, we met by videoconference during “74th RILEM Annual Week & 40th Cement and Concrete Science Conference” 31st of august 2020 and after 4th RILEM Spring Convention, from 6 to 9 April 2021.
• A special virtual-Workshop about stress corrosion cracking and hydrogen embrittlement in October/November 2021 is in preparation.

TES | Thermal energy storage in cementitious composites

Chair **Jorge SANCHEZ DOLADO**
Deputy Chair **Antonio CAGGIANO**
Activity started in 2020



Computational design of a sensible TES device based on concrete. Picture courtesy of J. S. Dolado.

Heat storage capacity of PCM using dynamic DSC tests. Picture courtesy of A. Caggiano.

Significance

• Energy supply is a vital issue, with special concerns of the public regarding the emission of greenhouse gases and the need to reduce the use of fossil fuels.
• Energy consumption in EU buildings counts with almost 40 percent of the total demand. Energy efficiency and novel technologies are considered the key pillars for limiting the high consumption for the new and existing building stock.
• The main challenge of most renewable energies (wind, solar, etc.) is to find appropriate energy storage devices to correct the mismatch between the supply and demand of energy.
• Concrete and cement-based materials present themselves as good solid material for Thermal Energy Storage (TES) applications, as they are abundant, cheap and have relatively good thermal capacities for such a purpose.

Relevance

RILEM TC TES is relevant for all researchers dealing with cement-based materials and/or energy storage materials, but also for industrials, end-users, standardisation and governmental bodies concerning with residential and non-residential buildings´ energy consumption.

Goals

The main objective of the RILEM TC TES is the production of a RILEM STAR report on cementitious TES devices. As natural secondary outcomes, the RILEM TC TES will also provide recommendations for characterizing and designing TES devices based on cement-based systems.

Methodology

RILEM TC TES will comprise a polyhedral viewpoint, addressing:
• Sensible, latent and chemical (and hybrids) cementitious TES systems.
• Experimental and computational perspectives.
• Multi-scale description: Components, composites, devices….
• Multi-application: Building efficiency, Industrial heat waste recovery, Solar plants, etc.

Progress

RILEM TES was approved in Summer2020 and held its kick-off meeting in December 2020. The second online meeting has taken place on the 5th of May 2021.

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 (290-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

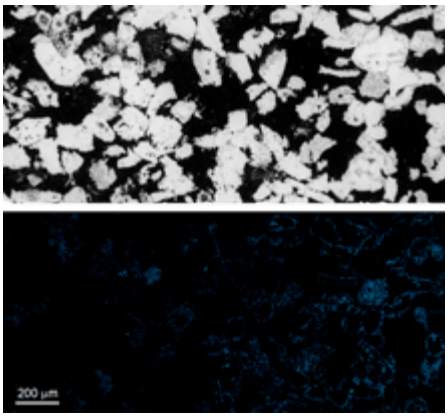
Code	Title	TC Chair	TC Deputy Chair	TC opened in
271-ASC	Accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization	Barbara LUBELLI	Inge RÖRIG-DALGAARD	2016
274-TCE	Testing and characterisation of earth-based building materials and elements	Jean-Claude MOREL	Antonin FABBRI	2016
277-LHS	Specifications for testing and evaluation of lime-based repair materials for historic Structures	Ioanna PAPAYIANNI	Jan VALEK	2017
290-IMC	Durability of Inorganic Matrix Composites used for Strengthening of Masonry Constructions	Antonietta AIELLO	Catherine PAPANICOLAOU	2019

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

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

	Massangis	Lympia	Tuffeau	Fired clay brick, type	Fired clay brick, type	Migné	Lecce stone	Prague sandstone
LRMH (FR)			1, 2			1, 2		
Getty Conservation Institute (US)			2					2
University of Cergy-Pontoise (FR)	1, 2				1, 2	1, 2		
KIK-IRPA (BE)	1, 2							1, 2
Newcastle University (GB)		2			2			
University of Orleans (FR)	1, 2		1, 2			1, 2		
Technical University of Denmark			2	2	2			
University of Cyprus (CY)		2		2		1, 2		
Delft University of Technology			1, 2			1, 2	1	
University of Bologna (IT)			2	2				2
University of Antwerpen (BE)			1				1	1
ETH Zurich (CH)					2			

Overview of the round robin test running at the different laboratories. 1= NaCl; 2= Na2SO4



Cross-section of Maastricht limestone contaminated with sodium sulfate in scanning electron microscopy (above), highlighting the pore filling through EDS false-color mapping (below). Photo Davide Gulotta. Picture courtesy of J. Paul Getty Trust.

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
• In the last year, 2 TC on-line meetings have taken place. Participation was larger than in previous meetings.
• A round robin test is on-going at 11 laboratories with 8 different materials, for validation of the developed procedure.
• The results of the work of the TC will be presented at the SWBSS2021 conference, co-sponsored by RILEM. 4 papers related to the work of the TC have been submitted to the conference.
• The TC plans to publish final procedure in 2022 in *Materials & Structures.*
• Nunes C. et al, (2021) Towards a more effective and reliable salt crystallisation test for porous building materials: Experimental research on salt contamination procedures and methods for assessment of the salt distribution, under review.
• D'Altri A.M et al, (2021) Towards a more effective and reliable salt crystallisation test for porous building materials: predictive modelling of salt distribution, under review.

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

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

Rammed earth building in Lyon, France. Image courtesy of Erick Saillet. Architects: Clément Vergely; Structural Eng.: Batiserf; Contractor: Nicolas Meunier-Le pisé.

On site prefabricated rammed earth walls before being assembled, Lyon, France. Image courtesy of Clement Vergely Architectes.

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

• 10 meetings held so far (latest on 13 March 2021).
• Round Robin Tests on mechanical properties: completed.
• Round Robin Tests on physical properties: scheduled for April-October 2021.
• STAR in press.
• A paper planned for submission to RTL (early July 2021).
• Results of mechanical testing planned to be published soon.
• Results of hygrothermal testing planned to be shared with TC275-HDB "Hygrothermal behaviour and Durability of Bio-aggregate based building materials".

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

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

Members of TC 277-LHS at work during the plenary meeting in November 2020. Imahe 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

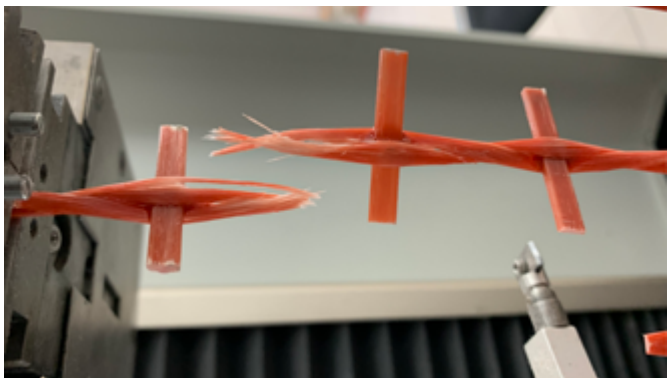
- Selection of all standards (EN, ISO, ASTM, etc) pertinent to testing quality of L-b-M.
- Review of suitability existing test methods in evaluating the performance of L-b-M.
- Propose adaptations/modifications to standard methods and field tests.

Progress

- Experimental work has stopped since March 2020. Hopefully, it will start again in September 2021.
- Three online meetings organised in May and November 2020 and in May 2021 with a very satisfactory attendance rate.
- I.Alvarez et al, RILEM TC 277-LHS report: a review on the mechanisms of setting and hardening of lime-based binding systems, Materials and Structures volume 54, Article number: 63 (2021)
- The RILEM Workshop Lime based materials for repairing historic Structures scheduled in Spring 2020 has been postponed due to Covid pandemic. New dates still to be announced (probably Nov 2021).
- Preparation of collective papers of WGs chaired by Caspar Groot, Rosario Veiga and Noi Maravelaki.
- Organization of the 6th Historic Mortars Conference (HMC2022), that will take place in Ljubljana 22-23 September 2022, has started.

290-IMC | Durability of inorganic matrix composites used for strengthening of masonry constructions

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



Tensile test of aged FRP grid utilized for CRM systems.

Failure of FRCM-strengthened masonry wall accompanied by fibers slippage. Image courtesy of the University of Salento.

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 IMC systems (also known as Fabric-Reinforced Cementitious Matrix - FRCM composites or Textile Reinforced Mortars – TRM) and practitioners who are asked to certify design by using this type of composites.
• 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 IMC materials in structural strengthening of masonry buildings.
• Experimentally assessing different 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 specifically addressing alkali attack on components (yarns, textiles, matrices) and composites.
• Assessment of post-ageing residual mechanical properties (e.g. through tensile 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. The STAR Table of Contents has been finalised, chapter leaders and contributors have been appointed, drafts of various chapters have been compiled.
• An extensive test campaign addressing the durability of IMC constituent materials and components under alkali attack has been designed. Various IMC producers have offered a variety of systems to be tested. A consortium of 26 labs has been brought together in order to participate to a distributed test plan (currently halted by the pandemic). Systems’ allocation and consortium logistics have been put in place.

Cluster F
Bituminous Materials and Polymers

Foreword
• from Cluster F Convener, **Eshan DAVE**

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, Cluster F, chaired by Eshan V. Dave, University of New Hampshire, USA, engages approximately 150 experts from 25 countries, and is composed of 7 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.

The first Cluster F International Symposium on Bituminous Materials (ISBM) took place in December 2020 in Lyon, France, presenting results from the RILEM TCs 264-RAP, 272-PIM, and 278-CHA. The Cluster F community was very delighted to congratulate its members Fernando Moreno-Navarro, University of Granada, Spain, and Augusto Cannone Falchetto, Aalto University, Finland, 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	Katerina VARVERI	2020
FEE	Fume Emissions Evaluation for Asphalt Materials	Johan BLOM	Laurent POROT	2021 **NEW!**

264-RAP | Asphalt pavement recycling

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

Cold recycling of asphalt pavement. Insert: Partially sealed drying of cold recycled asphalt specimen in lab that was part of the inter-laboratory testing effort of TC 264-RAP to improve laboratory curing procedures. Picture courtesy of A. Carter and 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

• RILEM TC 264-RAP online Industry Workshop held in connection to the RILEM International Symposium on Bituminous Materials (ISBM), on 17 December 2020.
• TC 264-RAP online meeting held during ISBM, 14-16 December, 2020.
• TC 264-RAP key-note presentation at the RILEM ISBM, 14-16 December, 2020.
• TC 264-RAP presentation at the 74th RILEM Annual Week "in" Sheffield, UK, September 2020.
• STAR is almost finished.
• 3 conference papers, published in the last 12 months: two presented at the RILEM International Symposium on Bituminous Materials (ISBM) and one at the 9th International Conference on Maintenance and Rehabilitation of Pavements (MAIREPAV).
• A Research Need Statement in preparation for publication on *RILEM Technical Letters*.

272-PIM | Phase and interphase behaviour of bituminous Materials

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

TC 272-PIM members. Image 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

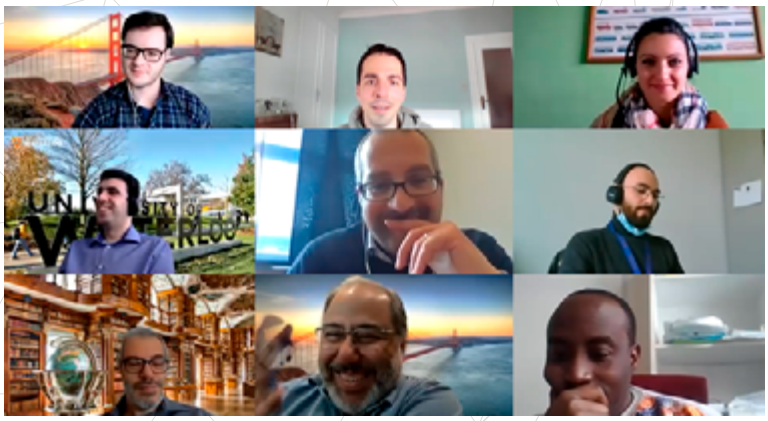
• The first period (one or two years) was dedicated mainly to experimental methods. During this period each Task Group (TG1: Binders, TG2: Mixtures, TG3: Pavement multilayer system) works independently.
• In a second phase, common innovative materials linked to actual sustainability issues will be chosen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

Progress

• TG1: Testing program was completed in April 2020 and results are going to be published.
• TC publications presented at ISBM2020 and EATA 2021 of preliminary results have initiated interest and fruitful discussion within the asphalt scientific communities.
• TG2: Round robin test completed.
• TG3: Testing program was completed in December 2019 and preliminary results have been already published on journals and conference proceedings (e.g. ISBM2020). Further data analysis is still in progress.
• Publication of TC STAR is expected in October 2021.

278-CHA | Crack-healing of asphalt pavement materials

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



Screen shot of online TC meeting held during COVID pandemic. Image courtesy of O. Baglieri.

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

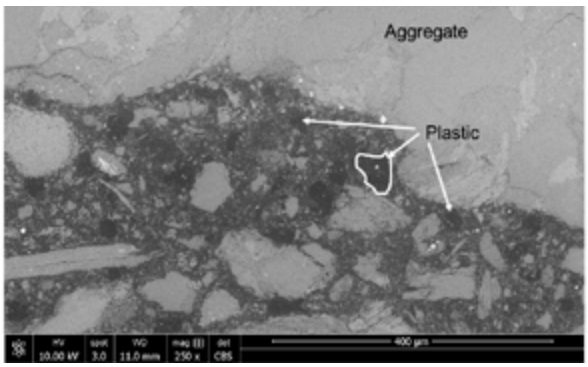
• TG1 (literature survey) has focused on i) cracking in flexible pavements and tests to induce and evaluate it, ii) different phenomena involved in the crack-healing process iii) investigating the different self-healing methods for bituminous materials.
• TG2 (laboratory experimentation) is currently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

Progress

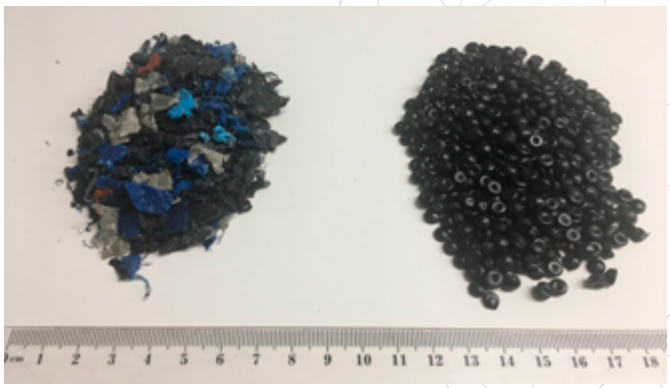
• STAR completed and to be published soon.
• TG2 experimental work is undergoing in 8 different universities and research institution.
• TG3 modelling work is undergoing in close collaboration with TG2.
• RILEM International Symposium on Bituminous Materials (ISBM Lyon 2020) – Plenary session on TC 278-CHA.
• Two papers accepted 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". Papers will be published in RILEM Bookseries in 2021.

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 showing plastic polyethylene particles in asphalt mixture. Image courtesy of Empa.



Plastic waste used in asphalt binder and mixtures. Picture courtesy of ZAG.

Significance

Use of various waste and marginal 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 such materials is knowledge on performance testing as well as environmental effects. The scientific community can 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 who have to solve non-routine problems.

Goals

• Identifying waste materials that have a potential to be performance enhancing components for roads.
• Enhancing the knowledge on suitable binder additives as well as appropriate aggregate substitutes and their respective 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 on suitable waste materials and their amounts for use in roads.

Methodology

Five technical groups (TG) have been formed:
• TG1 investigates the use of waste plastics as binder additives.
• TG2 evaluates the modification of asphalt binders with crumb rubber from end-of-life tires.
• TG3 focuses on replacing conventional aggregates with recycled waste materials such as C&D waste and steel slags.
• TG4 focuses on environmental assessment and potential sources of pollutants.
• TG5 will perform Life Cycle Assessment on the materials used in other TGs.

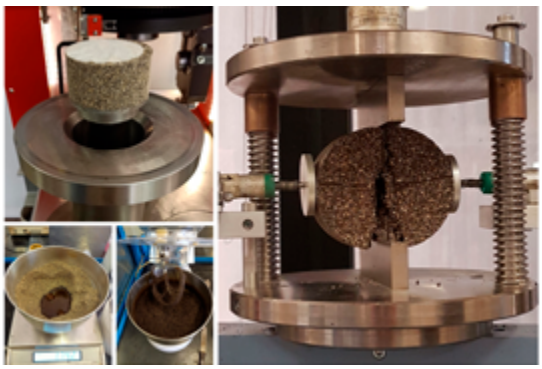
Progress

• RILEM TC 279-WMR Workshop "Valorisation of Waste and Secondary Materials for Roads", 17 Dec 2020 (online, 10 presentations, ≈ 100 participants).
• M. Pasetto et al. (2020) "An interlaboratory test program on the extensive use of waste aggregates in asphalt mixtures: preliminary steps", RILEM Bookseries, Vol. 27 – Proceedings, RILEM International Symposium on Bituminous Materials – ISBM Lyon 2020, On-Line Conference (ZOOM), 2020. (oral presentation)
• Preparation of STAR Report has started by identifying authors, draft outline and potential editors.
• TC activities will be presented at the 2nd edition of the Mediterranean PhD School, organised by the Department of Civil, Building and Environmental Engineering of the University Federico II of Naples (Italy), on 11-16 October 2021.

280-CBE | Multiphase characterisation of cold bitumen emulsion materials

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

Tests on slurry surfacings carried out within the TG2 interlaboratory test. Image courtesy of C. Sangiorgi, C. Raab and J. Oliveira.



Preparation and testing of mortar specimens within the TG1 interlaboratory test. Picture courtesy of A. Graziani.

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

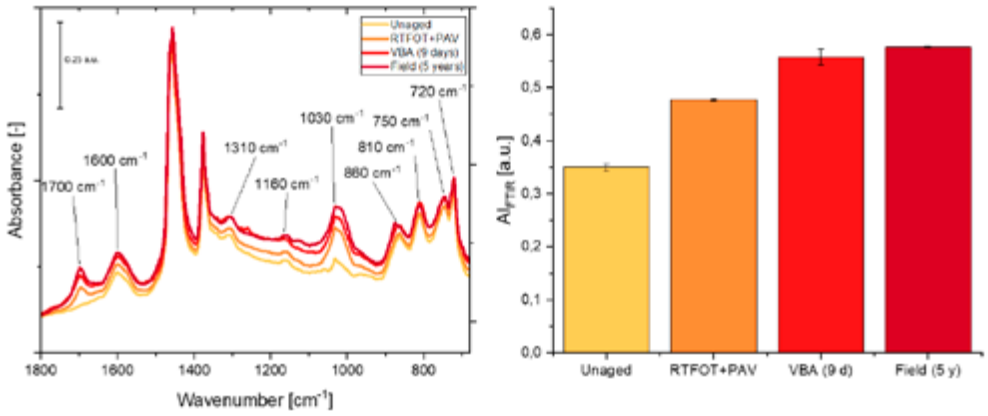
Two Technical Groups (TG) have been formed:
• TG1 focuses on the fundamental characterization of emulsions and emulsion-based composites (mastics and mortars).
• TG2 focuses on mixtures and technologies employed for non-structural paving applications (slurry surfacings).
Both TGs have organised Inter-laboratory tests (ILT) with the following objectives:
• TG1 – Delivering an unambiguous, robust, and practical methodology to link the properties of bitumen emulsions and performance of mixtures for structural layers.
• TG2 – Developing a consistent experimental framework for characterizing the mix design and performance properties of cold microsurfacings.

Progress

• TGs are currently performing inter-laboratory tests; 25 laboratories and 3 companies are involved in total
• The first results have been collected from the TG leaders from European Laboratories. Two additional emulsion batches have been shipped to China and Canada.
• Completion of experimental work is planned in 2022, followed by preparation of report and recommendations in the final TC years (2022/2023).

FBB | Fingerprinting bituminous binders using physico-chemical analysis

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



Evolution of the FTIR spectrum of bitumen with ageing (left) and oxidation-based ageing index (right). Picture courtesy of TC FBB.

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, rejuvenators or other additives. However, simple and standardized analysis methods to detect these additives 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

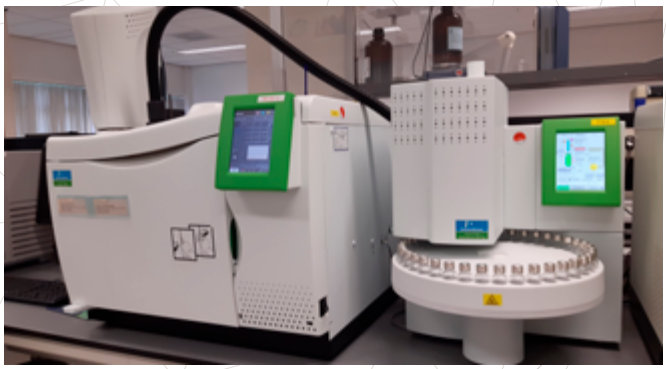
• Improving FTIR procedure for bitumen analysis.
• Providing the basis for standardized analysis of bitumen modification and its oxidative ageing.
• Implementing other rheological, spectroscopic and microscopic techniques to be used to link physico-chemical with rheo-mechanical information.
• Generation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

Progress

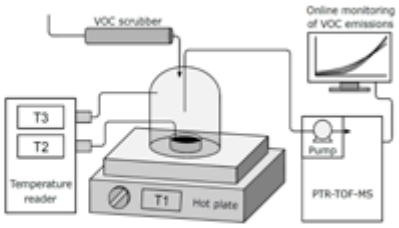
• The Kick-off meeting was held in September 2020
•Other TC meetings have been taking place in November 2020 and February 2021.
•The first Working Group (WG1) of the TC had its first meeting in April 2021 to prepare the details for a round robin test on FTIR. The WG2 had a meeting in May 2021 to develop a comprehensive definition of the term “fingerprinting”.
•Internal documents were prepared by the WG leaders with the laboratory procedures to be followed in the round robin tests on FTIR.
•The laboratory work in preparation of the round robin tests starts in summer 2021 by conditioning binder samples and shipping them to 20+ active members of WG1. The round robin tests on FTIR will start in fall 2021.

FEE | Fume emission evaluation for bituminous material

Chair **Johan BLOM**
Deputy Chair **Laurent POROT**
Activity started in 2021



Gas Chromatography-Mass Spectrometry for fume emission analysis. Courtesy of L. Porot, Kraton Polymers.



Proton-transfer-reaction time-of-flight mass spectrometry. Courtesy of J.Blom, Universiteit Antwerpen

Significance

• Bituminous materials are widely used for paving and roofing applications. During the manufacturing elevated temperatures are required. As organic-based material, the bituminous binder emits fumes and emissions, including Volatile Organic Components (VOC).
• Proper qualification and quantification of fume emissions from asphalt materials are gaining more and more interest today. However, there are various ways to define and quantify fume emissions from asphalt materials, but no standardised methodology has been established so far.

Relevance

The Rilem TC FEE is of particular interest for researchers and laboratories working on bituminous materials and construction, for laboratory equipment to improve and develop new means for industry and road authorities to develop a common knowledge platform of testing and methodology.

Goals

• The TC will aim at gathering existing experiences and protocols in the evaluation of fume emissions, even in small quantity, and collecting best practices through a literature review.
• Along with an inter-laboratory protocol, it will evaluate and benchmark different methodologies in terms of relevance, accuracy and practicality. It will scale from binder level, through asphalt mix up to full production and application.
• The ultimate goal is to define recommendations for practisers in evaluating, in an objective and repeatable way, the fume emissions of bituminous materials.

Methodology

• The Rilem TC FEE will be divided into three task groups working in parallel from binder, asphalt mix and application level. Each task group will include a state of the art via inter-laboratory activities to evaluate different protocols and compare each other, at binder, mix and application scale.
• Dissemination will be ensured via a regular update on Rilem space and publications.
• Academic and industry workshops will be organised to collect market and research needs.
• A State of the Art and final recommendations will be delivered at the end.

Progress

The Rilem TC FEE has been approved by the RILEM TAC in April 2021 and received already interest from more than 40 Rilem members. A kick-off meeting will be organised in Autumn 2021.

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Affiliation to Industry, Research Centre or Government body
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Concluding remarks
By the RILEM Presidents

Going through the pages of this third edition of the RILEM Technical report, it seems that the breadth and essence of RILEM's technical activities have not been affected at all by COVID! It is with immense pleasure that we see the flourishing of new initiatives and the smooth progress of the existing projects. We are blessed by active members and hard-working staff that has made possible, also this year, to achieve the RILEM goals.

Some of the RILEM activities and news circulated through the RILEM newsletter Bits&Bobs in the last 12 months.

A glance at the second half of 2020 and the first half of 2021 is presented in the following lines:

- We greeted and smiled at friends and colleagues through our webcams at the Annual Week "in" Sheffield, the first fully online RILEM event, in September 2020.
- We have announced many new Technical Committees and new initiatives – like GLOBE, the ROC&TOK webinars and the RILEM Youth Council.
- Our two journals, *Materials and Structures* and *RILEM Technical Letters*, have continued to publish outstanding papers authored by our members and the wider scientific community.
- Many other publications have been produced in the last 12 months, like conference proceedings and State-of-the-Art reports.
- We have welcomed new corporate members, renewed international partnerships and made new partners!
- We held our second fully-online event "in" Paris for the 4th RILEM Spring Convention and the RILEM Strategy Workshop, in April 2021. Thanks to the participation of our members at the Strategic Workshop, we have gathered precious information and ideas that we are currently analysing to find the best way to implement them.
- RILEM turned 75 in 2021! We presented the 75th RILEM Anniversary booklet in April. The final version will be officially distributed in September this year, at the 75th RILEM Annual Week, in Merida, Mexico.

Not bad for 12 months of lockdown, smart working, curfews, and restrictions of all sorts!

A hug goes to our members that lost their loved ones due to COVID pandemic. Image courtesy of M. Bianchetti.

We do not want to hide the difficulties we all went through. Some of us lost their loved ones. Our thoughts go to them and their families.

We try to be positive and proactive. We have discovered that although we all miss to meet in person colleagues and friends, online meetings are actually an easy way to connect when – time, financial and COVID - travel restrictions do not allow us to leave our offices. In this regard, we want to and we must acknowledge the RILEM Team, Judith Hardy - Secretary General, Anne Griffoin - Head of Publications and Communication, and Fanta Sylla - Management Assistant, for their excellent work in servicing our members and in particular also for organising the last RILEM Spring Convention and Strategy Workshop, establishing and managing the free ZOOM licenses for all TC Chairs, and for their support with the ROC&TOK webinars. The work of the staff at the General Secretariat in Paris goes beyond this, of course! We also recognise the terrific effort of the RILEM Implementation Manager, Daniela Ciancio, in increasing the visibility of RILEM through its social media channels, newsletter, establishing of partnership and for editing this report.

It seems that the most used business phrase in 2020 was "**I think you're on mute**". We do hope that the most used one in the following months will be "**long time no see**"!

Long time no see! We will shake hands again. Image courtesy of A. Calvar.

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