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

2021
2022

Technical Report

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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 are listed on the following page!

Individual fees in 2022

Young Member	€ 25	Retired Member	€ 75
Senior Member	€ 375		

Corporate fees in 2022

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:

- 40%: Algeria; Albania; Angola; Argentina; Bosnia and Herzegovina; Botswana; Brazil; Bulgaria; Chile; Colombia; Croatia; Dominican Republic; Ecuador; Egypt; Estonia; Hungary; Islamic Republic of Iran; Jordan; Kazakhstan; Latvia; Lebanon; Libya; Lithuania; Macedonia; Malaysia; Mauritius; Mexico; Montenegro; People's Republic of China; Peru; Poland; Republic of Costa Rica; Romania; Russian Federation; Serbia; South Africa; Thailand; Tunisia; Turkey; Ukraine; Uruguay; Venezuela.

- 60%: Bangladesh; Burkina Faso; Cambodia; Cameroon; Congo; Cuba; Ethiopia; Federal Republic of Nigeria; Georgia; Ghana; Guatemala; India; Indonesia; Iraq; Ivory Coast; Kenya; Lesotho; Malawi; Morocco; Mozambique; Nepal; Pakistan; Paraguay; Philippines; Republic of Moldova; Senegal; Sri Lanka; Syrian Arab Republic; Togo; United Republic of Tanzania; Viet Nam; Yemen, Zimbabwe.

Membership categories

RILEM is composed of corporate members and individual members, including scientists and engineers, research and testing laboratories and companies.

Corporate Members

- **Associate Members** are smaller research, academic or building organisations or companies.
- **Institutional Members** are research and testing organisations of national renown, universities, international or national standards organisations.
- **Industrial Members** are large firms or associations in the materials of construction sectors.

Individual Members

- **A Senior Member** is an experienced scientist or professional/practitioner, having reached a position of responsibility and recognised expertise in a public or private organisation or company concerned with testing or research in the field of building materials and structures.
- **A Young Membe**r (previously Student and Affiliate categories) is a post-graduate student (including PhD students) or a young research scientist or engineer who is at the early stage of his career, and who is under the age of 35 during the membership year.
- **A Retired Member** is a member who has retired.

Benefits

Benefits for all members (individual and corporate members included):

- Membership in the RILEM Technical Committees (strongly recommended to not join more than 3 TCs at a time), allowing *i*) to participate in the Technical Committee meetings, *ii*) to be listed as author of the Technical Committee outputs/publications and as a member on the RILEM website, and *iii*) to have the possibility to directly propose a new Technical Committee to the Secretariat General.
- **Opportunity to publish** selected articles as free Open Access papers in *Materials and Structures* and in *RILEM Technical Letters*.
- **Free subscription to the online version of *Materials and Structures* journal** hosted by Springer (access to the current issues and to archives since 1968).
- **Access to online RILEM Proceedings** published by RILEM Publications and Springer, and to online reports published by RILEM Publications.
- Benefit of a **20% discount on all SPRINGER e-books**.
- If requested, **subscription to the printed version of *Materials and Structures*** journal, at a special price of 150 €/year.
- **Access to RILEM online Directory of Members.**
- **Reduced fees for RILEM events** (in general 10%, subject to decision of local organisers).

Corporate members additional benefits:

- **A certain number of staff members can enjoy the RILEM member benefits:**

- Associate Members can have 3 staff members and one associate contact.
- Institutional Members can have unlimited staff members.
- Industrial Members can have unlimited staff members.

- **Logo of the company displayed on RILEM presentation and RILEM Annual Report.**
- **Logo and short description of the company** displayed on the RILEM Website, with a link to the corporate member website, for a better visibility.

Editorial

by RILEM TAC Chair Enrico SASSONI

I have the pleasure and honour to open this 2021-2022 edition of the RILEM Technical Report with this Editorial, written in the last three years by Prof. Nele De Belie, former RILEM TAC Chair, whom I thank for her excellent job!

Firstly, for those I have not had the pleasure yet to meet and work with, let me introduce myself: I am Dr Enrico Sassoni, Associate Professor in Science and Technology of Materials at the Department of Civil, Chemical, Environmental, and Materials Engineering of the University of Bologna, in Italy. I have been elected RILEM TAC Chair in September 2021. I am not new to RILEM: I received the RILEM Gustavo Colonnetti medal in 2017, I have been member of several TCs, I had been Convener of Cluster E "Masonry, Timber and Cultural Heritage" between 2018 and 2021, I am currently Deputy Editor in Chief of *Materials and Structures* and Associate Editor of *RILEM Technical Letters*.

Hoping I am not too optimistic, I cautiously would like to say that we are leaving COVID behind and slowly getting back into the pre-COVID routine. A sign of this return to pre-COVID standards was the RILEM First International Conference on Earthen Construction, celebrated in conjunction with the 2022 RILEM Spring Convention this year. This conference was the first RILEM event held 100% in person since COVID hit us, and it was a great success! You can read more about this event and the Spring Convention in the following pages of this report.

Over the last years, despite the pandemic, RILEM members have been very active in organising online and hybrid events, in publishing TC outputs, and in engaging in new research trends. On this matter, as former Cluster E Convener, I must acknowledge the flourishing of the "earthen building materials" community that has found its home in RILEM. TC 274-TCE: Testing and characterisation of earth-based building materials and elements cautiously started 6 years ago with some 15 members. After having produced a STAR, organized a conference, and published several journal articles, this TC, with now more than 30 members, is close to its termination but it is handing over the reins to 3 new TCs: BEC - Bio-stabilised earth-based construction: performance-approach for better resilience, MAE - Mechanical performance and durability assessment of

earthen elements and structures, and PEM - Processing of earth-based materials.

Another growing community is that working on concrete Digital Printing Technologies. Cluster A has 2 new TCs on this subject: PCC Pumping of concrete and PFC Performance requirements and testing of fresh printable cement-based materials. The latter TC has almost 80 members!

RILEM also welcomes a new research topic amongst its themes, never treated before for obvious reasons: Artificial Intelligence (AI). The recently established TC DCS Data-driven concrete science will investigate the use of AI in concrete structures. Fascinating, isn't it?

Considering the increasing importance of sustainability in today's society, especially regarding the impact of the construction sector onto the environment, RILEM has also thought of introducing an item specifically dedicated to the environmental aspect in the proposals for new TCs to be established in the future.

You can read the details and progress of all active RILEM Technical Committees in this report that, for this issue, has developed a different format. The TCs established over the last 12 months are presented in detail through 5 headings: Significance, Relevance, Goals, Methodology, and Progress. The TCs established before September 2021, that have been already described in detail with the above mentioned 5 headings in the past issues of the RILEM Technical Report, are hereby presented with two headings: Significance and Progress. Independently of the format, the content is still pure gold! I hope you enjoy it!

Table of Contents

An overview

of the 2022 RILEM Spring Convention and RILEM 75th Anniversary Events

Paris, France, 14-19 March 2022

The 2022 RILEM Spring Convention was a hybrid set of events held at the new headquarters of RILEM, at the University of Gustave Eiffel, in Paris, France. In brief, this is what happened:

- The Standing Committees EAC, TAC, DAC and Bureau met on Monday 14, Tuesday 15 and Wednesday 16 March.
- On Thursday 17 March, the 75th RILEM anniversary was celebrated with a full-day webinar rich of presentations and discussions.
- The First International Conference on Earthen Construction was held in person on Friday 18 and Saturday 19 March.

Standing Committees

The Standing committee meetings were held in hybrid mode over 3 days. The RILEM officers who attended in person were welcomed by the hospitality of the RILEM General Secretariat staff. It was wonderful to shake hands again!

The occasion was also marked by the introduction of less restrictive Covid measures in France according to which it was no longer compulsory to wear masks in offices, schools, and shops.

At the EAC meeting, the agenda of the upcoming EAC events and the performance of the past events were reviewed. The ROC&TOK webinars stood out as a very successful series with high number of online participants and YouTube viewers. The proposal of the RILEM Youth Council to organise a new series of peer-to-peer webinars was enthusiastically welcomed and approved by the members of EAC. The first two of this series of events have taken place in May (Sustainability through durability) and July (3D Printing and Nanotechnology for Sustainable Construction) 2022.

RILEM officers and staff attending in person the RILEM Spring Convention in Paris. From the left: Wolfram Schmidt, Ravindra Gettu, Anne Griffoin, Aurelie Martingale, Daman Panesar, Daniela Ciancio, Nele De Belie, Gabriele Tebaldi, Mohammed Sonebi and Judith Hardy. Picture courtesy of W. Schmidt.

RILEM officers during a Standing Committee meeting. Picture courtesy of D. Ciancio.

At the TAC meeting, the discussion about the implementation of ideas suggested at the last RILEM Strategic Workshop was resumed, like for instance, the importance of tracking the impact of RILEM in general, and more specifically tracking the impact of the work of the RILEM Technical Committees, and the involvement of more RILEM industry members into the activities of all RILEM TCs.

TC 267-TRM Tests for reactivity of supplementary cementitious materials was officially closed. 8 new TCs were approved:

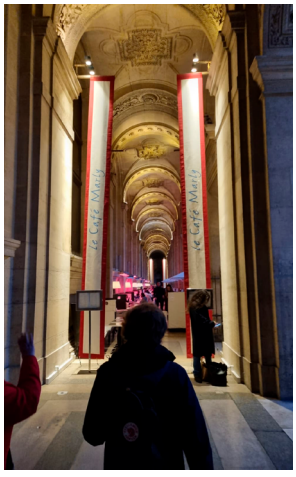
- MCP Accelerated mineral carbonation for the production of construction materials, chaired by Ruben Snellings; Cluster A
- CFR Concrete during fire - Reassessment of the framework, chaired by Pierre Pimienta; Cluster C
- OCM On-site corrosion condition assessment, monitoring and prediction, chaired by Carmen Andrade; Cluster C
- DCS Data-driven concrete, chaired by Sandra Nunes; Cluster D
- PEM Processing of earth-based materials, chaired by Emmanuel Keita; Cluster E
- PAR Performance- based asphalt recycling, chaired by Gabriele Tebaldi; Cluster F
- MAE Mechanical performance and durability assessment of earthen elements and structures, chaired by Antonin Fabbri; Cluster E
- BEC Resilience and durability of bio-stabilised earth-based construction: testing methods based on performances approach, chaired by Ana Bras; Cluster E.

At the DAC meeting, DAC members finalised the discussion started at the meeting “in” Merida last year (75th RILEM Annual Week) about the implementation of ideas suggested at the last RILEM Strategic Workshop: the relationship with the industry sector and new opportunities for RILEM Young members. The RILEM membership figures, with the number of RILEM members going up and the current situation of the RILEM social media channels and newsletter were shown.

At the Bureau, Bureau members discussed the emphasis of the environmental aspects of the work of a TC. Furthermore, the details of the future Spring Conventions and Annual Weeks were presented by the corresponding organisers. Here comes a list of the upcoming events:

RILEM Annual Weeks
- 2022 - 76th Annual Week, Kyoto, Japan
- 2023 - 77th Annual Week, Vancouver, Canada
- 2024 - 78th Annual Week, Toulouse, France
- 2025 - 79th Annual Week, Hanoi, Vietnam
- 2026 - 80th Annual Week, Nairobi, Kenya

RILEM Spring Conventions
- 2023 - Rabat, Morocco
- 2024 - Milano, Italy
- 2025 - Mendrisio, Switzerland
- 2026 - Ghent, Belgium


RILEM Dinner: the RILEM officers attending in person the Standing Committee meetings were treated with a dinner at “Le Café Marly”, next to the Louvre Museum in Paris. Pictures courtesy of D. Ciancio and W. Schmidt.

Celebration of the RILEM 75th Anniversary: Webinar event

The celebration of the 75th anniversary of RILEM was a fully online event that started with the welcoming speech of Dr Nicolas Roussel, RILEM President. It continued with three sessions: 1) *RILEM Main Traditional Subjects, Construction Materials & Research,* 2) *Sustainability & Future of Construction* and 3) *Strategy & Perspective of RILEM.* The first two sessions were made up of 10 presentations in total, all available on the RILEM YouTube Channel. The speakers were internationally recognised experts who presented the "State of the Art" of different research areas like, for instance, earthen materials, digital fabrication, concrete durability, etc… The first two sessions were set apart for the Award Ceremony, during which the 2022 RILEM Gustavo Colonnetti medallists, Dr Ellina Bernard and Prof. Qing-Feng Liu, presented their work. The presentations of the 2022 RILEM medallists are also available on YouTube. The third session was a panel discussion amongst the Chairs of the Standing Committees, the Editors in Chief of the RILEM journals, *Materials and Structures* and *RILEM Technical letters*, and the RILEM Presidency. The panel members discussed about Open Access strategy, science popularization and participatory research, GLOBE, RILEM Youth, leadership and inclusivity. Prof. Ravindra Gettu, Past RILEM President, presented the concluding remarks at the end of the day. Each session had an average of 200 attendees with a total of 425 participants connecting from around 60 different countries (RILEM is an international organization, indeed! Isn't it?) from Uganda to Kazakhstan, from Cameroon to Ireland. The most represented countries were France, Germany, India, UK, and USA.

First International Conference on Earthen Construction

It was the first RILEM event held in person in the last 2 years! The conference was organised by RILEM TC 274-TCE: Testing and characterisation of earth-based building materials and elements. This event gathered around 130 delegates from 9 different countries (France, Switzerland, Portugal, Canada, Germany, Turkey, United Kingdom, Denmark, and Burkina Faso). It consisted of 2 keynotes, 6 invited lectures and 65 short presentations. The two Best PhD presentation awards were given to: 1) Sofia Roucan from UPPA and ENTPE, France, and 2) Pierre Estève from the University of Edinburgh, UK.

Many young researchers attended the conference, making the average age of the delegates maybe the most striking aspect of this event. The Gala Dinner was organised at the restaurant "Le Train Bleu" in Paris, on Friday night. The Second International Conference on Earthen Construction will be organised in 2024!

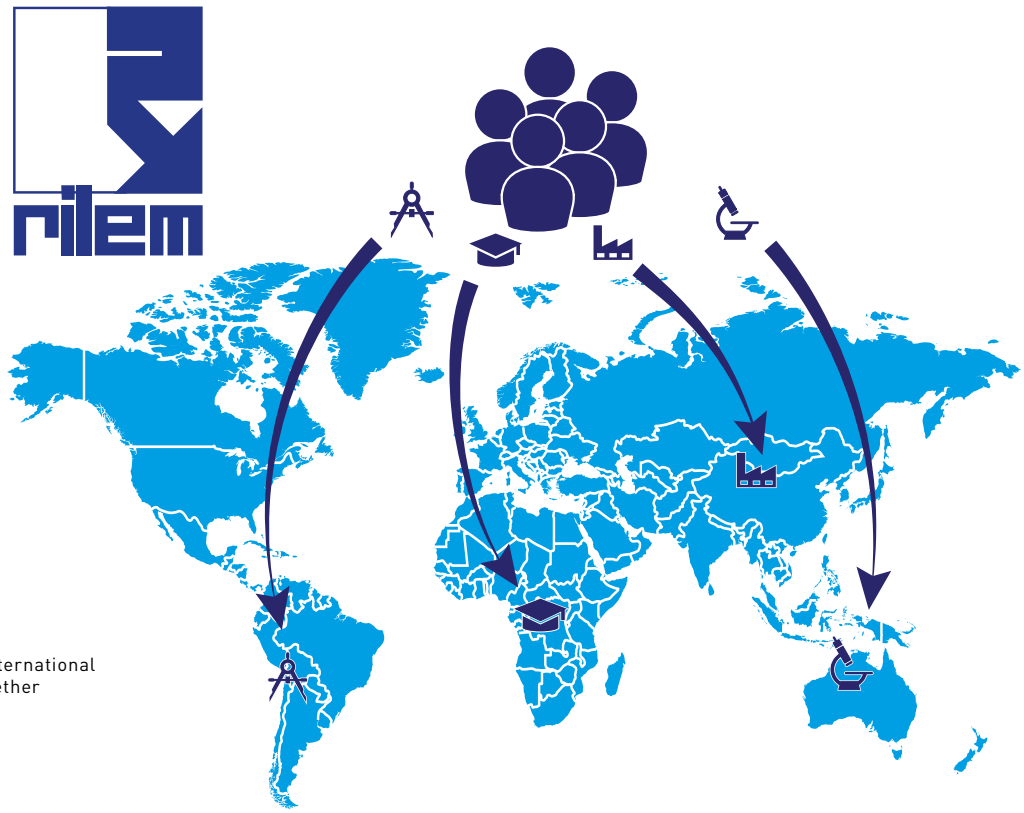
Dr Emmanuel Keita, Chair of the organising committee, opening the conference. Image courtesy of D. Ciancio.

From the left: Prof. Henri Van Damme, keynote speaker, Dr Emmanuel Keita, Chair of the organising committee, and Dr Nicolas Roussel, RILEM President. Image courtesy of E. Keita.

2022 Colonnetti medallist, Dr Ellina Bernard, and RILEM President, Dr Nicolas Roussel. Image courtesy of J. Hardy.

Some moments during the gala dinner at the restaurant "Le Train Bleu". Images courtesy of D. Ciancio.

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

Each RILEM TC is of utmost importance to the organisation since the building of scientific and technical expertise, and dissemination of recent results and development form the core of RILEM's mission.

How is a RILEM TC created?

An application is filled and signed by the proposed TC Chair, who has to be a RILEM Individual Member. This form is sent to the RILEM General Secretariat that forwards it to the members of the RILEM Technical Activities Committee (TAC) 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 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. Although a TC proposal can be received any time of the year, the final discussion and approval happens twice a year, usually in March (RILEM Spring Convention) and September (RILEM Annual Week), when TAC and Bureau meetings are held.

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 TAC. Each Cluster is chaired by a Cluster convener. The 6 fields of activities currently treated by active RILEM TCs are:

- Cluster A. Material Processing and Characterization (Convener: Daman Panesar)
- Cluster B. Transport and Deterioration Mechanisms (Convener: Josée Duchesne)
- Cluster C. Structural Performance and Design (Convener: Giovanni Plizzari)
- Cluster D. Service Life and Environmental Impact Assessment (Convener: Anya Vollpracht)
- Cluster E. Masonry, Timber and Cultural Heritage (Convener: Arun Menon)
- Cluster F. Bituminous Materials and Polymers (Convener: Eshan Dave)

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 join a TC?

Yes! Anyone is welcome to join a RILEM TC. RILEM values the contribution of everyone, no matter if you are a young PhD student, an experienced researcher, or an industry practitioner.

Membership & authorship

1. If you are a RILEM subscribing member who actively contributes to the TC activities and outputs (articles, TC reports, STARs, etc), you are listed as a TC member and as author of the TC publications.

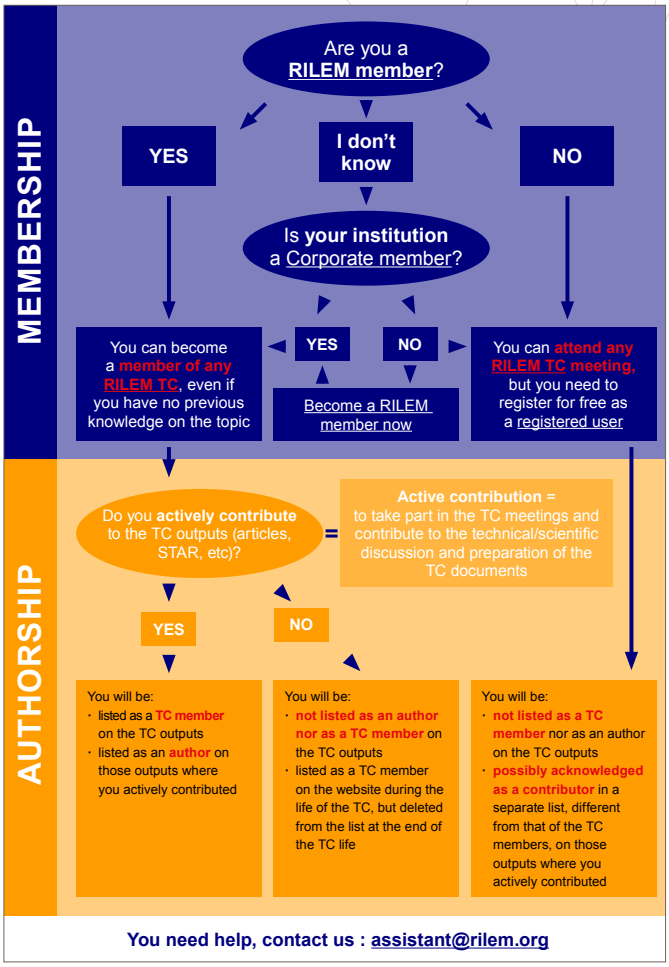
2. If you are not a RILEM subscribing member, you need to become a registered user by clicking on "CREATE YOUR FREE ACCOUNT" here and filling in your contact details. This step does not involve any cost/payment. As a registered user, you are welcome to join the TC meetings, to receive the produced documentations[1], and to be part of the activities of the TC. However, you will not be listed as a TC member nor as an author of the TC outputs. You could possibly be acknowledged as a contributor in a separate list on those outputs where you actively contributed.

The membership fee gives access to many benefits, amongst which the rights to TC membership and authorship. It is not an "entrance fee" for being allowed to contribute to the TC work.

Background and age

TC chairs should be inclusive and not refuse any request from anyone (RILEM members and not) wishing to become part of their TC; this also applies when the TC could have been running for a few years, unless it is about to close. This spirit aims to encourage as many minds as possible to engage in new topics and contribute to the research. RILEM would like to remind that young researchers, like PhD students, are strongly encouraged to join a TC.

Scheme of TC membership and TC publications authorship.



How can i join a rilem TC?

You can submit the registration form available on the RILEM website.

Rewards for TC members and participants

Joining a RILEM TC offers many 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*

1. Confidentiality Clause: None of the working documents of the TC should be circulated, duplicated or copied by any means, or published on any web page, journal, proceedings of conferences, etc. Any TC member and participant is bounded with this mandatory rule. Any publication of RILEM TC working documents is submitted to the rules defined by RILEM. Until official publication by RILEM, such working documents should remain confidential.

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 also an opportunity to work with the best scientists in their field of expertise, 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.

Other benefits when joining a TC

Beside the above-mentioned benefits, joining a RILEM TC also means:

1. For RILEM subscribing members:
   - Access to agendas and minutes of the TC. Those can be accessed through the private directory if uploaded by the TC chair and/or Deputy-chair.
   - Access to any other document produced by the RILEM Technical Committee.
   - Access to the Directory of Members.

2. For non-RILEM members:
   - Access to the documents produced by the RILEM Technical Committee, sent by email.

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.

For more details, see the chapter "RILEM Publications" in the following pages on this report.

RILEM Publications

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

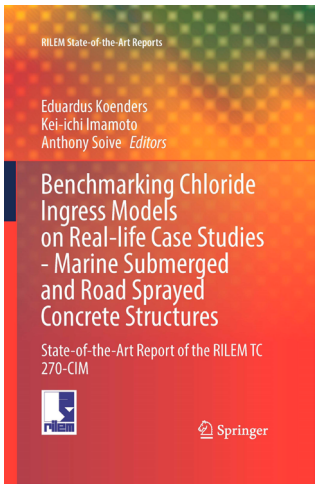
RILEM Publications corner at the INTERNATIONAL CONFERENCE ON ADVANCES IN SUSTAINABLE CONSTRUCTION *MATERIALS AND STRUCTURES* venue, Merida, Mexico, September 2021. Image courtesy of A. Griffoin.

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.

Anyone can download for free from the RILEM web page the unedited version of each RILEM STAR, as PDF «unedited version».

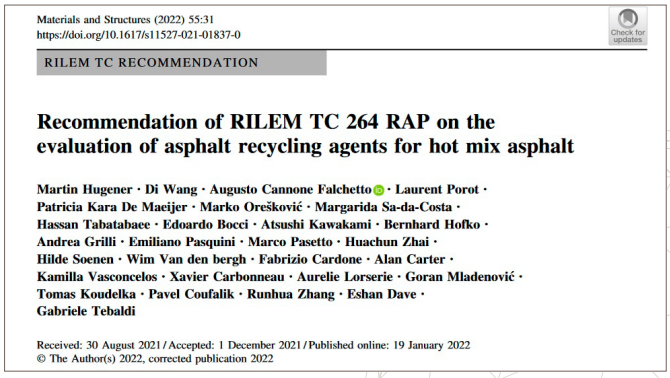
Recently, RILEM has initiated the series of STARs in a Nutshell. These documents should not be considered as a summary of the exhaustive work of the RILEM Technical Committees, but more like a brief overview of the contents available in the STAR. The purposes of these "STARs in a Nutshell" are: 1) to 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 last "STARs in a Nutshell" published in the last 12 months are presented in this report.



Cover of STAR of TC 270-CIM. Courtesy of Springer.

Recommendations

Over 200 RILEM Technical Recommendations have been produced by the 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*. They are free to be downloaded for all.


Materials and Structures (2022) 55:31
https://doi.org/10.1617/s11527-021-01837-0

RILEM TC RECOMMENDATION

Recommendation of RILEM TC 264 RAP on the evaluation of asphalt recycling agents for hot mix asphalt

Martin Hugener · Di Wang · Augusto Cannone Falchetto · Laurent Porot · Patricia Kara De Maeijer · Marko Orešković · Margarida Sa-da-Costa · Hassan Tabatabaee · Edoardo Bocci · Atsushi Kawakami · Bernhard Hofko · Andrea Grilli · Emiliano Pasquini · Marco Pasetto · Huachun Zhai · Hilde Soenen · Wim Van den bergh · Fabrizio Cardone · Alan Carter · Kamilla Vasconcelos · Xavier Carbonneau · Aurelie Lorserie · Goran Mladenović · Tomas Koudelka · Pavel Coufalik · Runhua Zhang · Eshan Dave · Gabriele Tebaldi

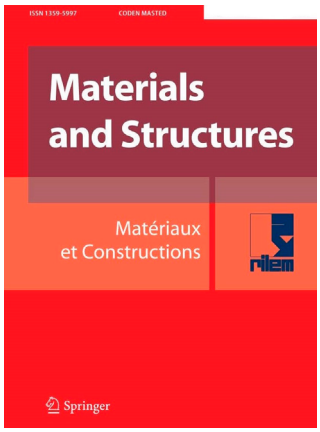
Received: 30 August 2021 / Accepted: 1 December 2021 / Published online: 19 January 2022

Recommendation of RILEM TC 264-RAP. Courtesy of Springer.

Proceedings

RILEM has been organising symposia and workshops since its foundation, with more than 100 proceedings published by RILEM Publications S.A.R.L. A quick glance at the RILEM 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 by non-RILEM members) from the RILEM website. Non-RILEM members 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 38 volumes in this RILEM Bookseries, available here.

Materials and Structures



Cover page of RILEM flagship publication "*Materials and Structures* / Matériaux et Constructions" (MAAS). Courtesy of Springer.

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. This journal publishes the articles of the RILEM L'Hermite Medallists.

In celebration of the 75th Anniversary of RILEM, the Topical Collection "75 years of RILEM: Materials and Structures" was released in February 2022 by *Materials and Structures*. This collection offers 25 papers, each of them presented with an introduction written by an expert in the field. The collection also features a preface from RILEM President, Dr Nicolas Roussel, explaining the selection criteria for these papers and their relevance in the scientific community.

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. This journal publishes the articles of the RILEM Colonnetti Medallists. It has recently featured some special regional papers, describing and detailing the state of the art of a topic in a certain geographical area. So far two papers have been published:

RILEM
technical letters

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

1. Innovation potentials for construction materials with specific focus on the challenges in Africa, Wolfram Schmidt, Mike Otieno, Kolawole Adisa Olonade, Nonkululeko W. Radebe, Henri van Damme, Patience Tunji-Olayeni, Said Kenai, Angela Tetteh Tawiah, Kuukuwa Manful, Akeem Akinwale, Rose N. Mbugua, Andreas Rogge, *RILEM Technical Letters* (2020) 5: 63-74;
2. Overview of cement and concrete production in Latin America and the Caribbean with a focus on the goals of reaching carbon neutrality, Yury Villagrán-Zaccardi, Ricardo Pareja, Lina Rojas, Edgardo Fabián Irassar, Andrés Torres-Acosta, Jorge Tobón, Vanderley M. John. RILEM Technical Letters (2022), 7: 30-46.

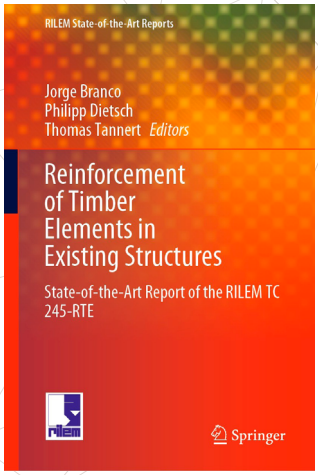
STARs in a nutshell

In the following pages, the STARs-in-a-nutshell published in the last 12 months are presented. An electronic copy of all the STARs-in-a-nutshell published so far can be downloaded from the RILEM website.

STAR in a nutshell 245-RTE "Reinforcement of Timber Elements in Existing Structures"

RELEVANCE of STAR 245-RTE

RILEM has a long history of Technical Committees working on subjects related to timber. The first one was in the very early days of RILEM, namely TC 003-TT: *Testing methods of timber.* Many more TCs followed after that one. In 2011, Dr Jorge Branco and Dr Philip Dietsch set up TC 245-RTE: *Reinforcement of Timber Elements in Existing Structures.* The establishment of this TC was triggered by the significant widening in the range of structural applications of timber over the past decades on one side, and, on the other side, by the acknowledgement of the need for the maintenance and upgrading of existing buildings for economic, environmental, historical and social concerns. The State-of-the-Art Report of RILEM TC 245-RTE *Reinforcement of Timber Elements in Existing Structures*, edited by J. Branco, P. Dietsch and T. Tannert was published in April 2021.



Reinforcement of Timber Elements in Existing Structures - State-of-the-Art Report of RILEM TC 245-RTE. Image courtesy of Springer.

Existing timber structures, and their reinforcement, need continuous assessment for motivations such as change of use, upgrade to better seismic performance, extreme events and/or poor maintenance that might damage them. The existing design standards and building codes lack rules and guidelines on this matter. Nevertheless, the practice of reinforcing structural timber systems can be considered a common one as there are plenty of existing techniques that are adopted and put into practice everyday around the world.

TC 245-RTE: *Reinforcement of Timber Elements in Existing Structures* was established in 2011 with the aim of reviewing the existing reinforcement practices, highlighting their limitations, and suggesting their improvements. This work was carried out over 8 years by 16 RILEM members and 1 contributor, from all over the world. A particular emphasis was given to the work done by the standardization committee responsible for drafting the European Timber Design standard, Working Group 7 "Reinforcement", of Eurocode 5, CEN/TC 250/SC 5. In 2021, the TC members released the State-of-the-Art Report of RILEM TC 245-RTE *Reinforcement of Timber Elements in Existing Structures.*

Part I of this document presents the currently available tools to reinforce existing timber structures: self-tapping screws, glued in rods, fibre-reinforcement polymers, and nanotechnology. For each of these reinforcement methods, their properties are reviewed together with the design approaches, the areas of application, the surface preparation procedures, and the factors that will affect their performance, like timber creep, shrinkage, and moisture content, to mention a few.

In Part II of this document, several applications of reinforcement are discussed. These include traditional structures, traditional timber frame walls, light-frame shear walls, roofs, floors, and carpentry joints.

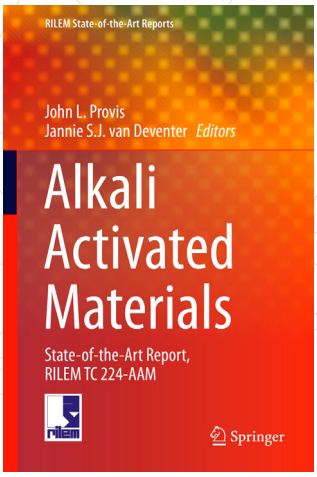
One chapter is dedicated to the seismic reinforcement of traditional timber structures. Examples of successful and catastrophic past interventions are used to identify effective and economical strengthening solutions.

Still with a focus on their seismic performance, also timber frame walls are analysed. Their performance under horizontal actions, and the reinforcement of their joints, are crucial when these walls are used as shear walls.

Light frame wood lateral structural systems, very common in North America, are susceptible to collapse during an earthquake, as many of the modern existing buildings were designed before the introduction of seismic building codes. Conventional and novel retrofit solutions are discussed to improve the seismic behaviour of these systems.

The retrofitting techniques used on historic timber roofs are also the subject of an extensive review that highlights how critical the phase of the assessment of the state of the timber system and elements is, as well as the need of using reinforcements that are compatible with the intervention.

Timber floors are found in historic and modern structures and retrofitting them is a very active area of research. They cannot be analysed as isolated elements as they are part of a more complex system made of their supports and connections with vertical elements.
The reinforcement of traditional timber carpentry is discussed in the last chapter of this document. Their failure mechanisms, such as compressive crushing, shear and tensile cracks, are presented in the context of reinforcing methods.



Alkali-Activated Materials - State-of-the-Art Report of RILEM TC 224-AAM. Image courtesy of Springer.

STAR in a nutshell 224□AAM "Alkali-Activated Materials"

RELEVANCE of STAR 224-AAM

TC 224-AAM was the first RILEM Technical Committee to address the topic of alkali-activation as a method of producing construction materials. The objectives of Technical Committee 224-AAM was primarily to analyse the state of the art in alkali activation technology. With this as main objective in mind, the Committee was formed in 2007 and STAR 224-AAM was published in 2014. Further work toward the identification of appropriate testing methods has been further developed through the work of successor committees including TCs 247-DTA, 283-CAM, and 294-MPA.

Alkali activated materials (AAMs) are generated by the reaction of alkaline activators with aluminosilicate-containing solid precursors. The alkali sources used as activators can include alkali hydroxides, silicates, carbonates, sulfates, aluminates or oxides – essentially any soluble substance which can supply alkali metal cations, raise the pH of the reaction mixture and accelerate the dissolution of the solid precursor. The solid aluminosilicate-rich precursors are generally those which are familiar in use as supplementary cementitious materials, such as metallurgical slags, calcined clays, natural pozzolans, and combustion ashes.

There have been **different factors motivating the scientific developments in AAM** depending on economic, regulatory and climatic factors in different parts of the world, and this is reflected to some extent in the ways in which the technology has evolved.

AAM technology has been developed and implemented in a number of countries for differing reasons over the past century, most prominently since the mid 1950s in the former Soviet Union, in the context of a demand for Portland cement (PC) alternatives. In China, the key driver in the initial stages of the development of this technology was the demand for high-strength concretes with low energy requirements during production. In Europe, the motivation behind the AAM research was essentially the pursuit of new construction materials able to compete in performance with PC, but with a much lower environmental impact. In Australia, research activity in AAMs was initiated in the mid-1990s, with the primary initial aim of developing methods of treating and immobilising mining wastes containing elevated levels of heavy metal contaminants.

The recent **focus on global warming**, public and consumer preference for «green» products, and the associated market in carbon credits, have all now combined to make AAMs for

the first time a viable large-scale proposition in the (conservative) cement and concrete industry. One of the often-claimed advantages of alkali activated materials over traditional Portland cements is the **much lower CO_2 emission** associated with AAM production, due to the avoidance of a high-temperature calcination step in AAM synthesis from ashes and/or slags. While further work is clearly needed in generating and validating life-cycle assessments of AAM products in specific applications, and particularly in understanding the emissions footprint of the activator components, this does appear to be a primary pathway for the wider use of AAMs in a carbon-constrained world.

Alkali activation technology also provides the opportunity for the **utilisation of waste streams** that may not be of significant benefit in PC-blending applications. For example, work on magnesia-iron slags, ferronickel slags, and tungsten mine waste, which would otherwise have little commercial value, has shown that these materials can be effectively converted to valuable materials by alkali activation, while they are of little or no benefit as mineral additions to PC.

The **mechanical properties** of AAM elements can definitively be competitive (if not better) when compared to those of PC concretes. Although no single formulation will achieve all of these characteristics simultaneously, AAMs can be designed to show, amongst other properties: abrasion resistance, resistance to high temperature and fire, resistance to acid and chemical attack, low susceptibility to degradation by alkali-silica reaction, excellent compressive and flexural strength, low permeability and low cost.

Two of **the major barriers** to the introduction of a new material into the construction industry are: (1) the need for standards in each governmental jurisdiction and (2) the open questions relating to durability of concrete. These are each being addressed through ongoing work in the RILEM community and other organisations.

The most critical role of the alkaline activator in an AAM is to accelerate the activator-precursor reaction to take place within a reasonable timeframe for the production of an engineering material, and this is most readily achieved by the generation of an elevated pH. Alkali-activated binders require the identification and optimisation of the most desirable activator chemistry for each precursor. The **main precursors** of interest can usefully be classified according to their calcium content:

Calcium-rich precursors: these are blast furnace slag (BFS) and other Ca-rich industrial by products. The effect of variability in BFS chemistry between sources is important in defining AAM behaviour, and requires further investigation to enable more accurate predictions of material performance.

Low-calcium precursors: these are low-calcium or calcium-free systems, often derived from fly ashes or clays. Low-calcium AAM binders are often referred to as “geopolymer”. The use of alkali metal hydroxide or silicate solutions with these precursors has in general provided the products with the highest mechanical performance, while carbonate or sulfate activating solutions are in general less effective in the absence of high levels of calcium.

Blended systems: a combination of a calcium-rich precursor with a predominantly aluminosilicate precursor can be used to form a hybrid alkali-activated binder system. This is an area in which there is a wealth of empirical information available, but only a much smaller number of detailed scientific studies, and certainly provides a good deal of scope for future scientific and technical developments.

Alkali activated materials (AAMs) do not conform to most **national and international cement standards**, which are inherently based on the composition, chemistry and hydration products of Portland cement and its blends. The large variety of approaches to formulation and production of AAMs makes it seem almost impossible to prescribe this class of new materials in the same narrow compositional and procedural way that has been adopted by the PC market over the last 150 years. So, TC 224-AAM reached the conclusion that standards development for AAMs should adopt a predominantly performance-based approach. An exhaustive survey of the existing cement and concrete standards available at the time of publication and relevant to Alkali Activated Materials (AAM) is available in the STAR.

An overview of the available test methods for **assessment of the performance** of construction materials under a wide variety of modes of attack is provided in the report in terms of

'chemical', 'transport' and 'physical' degradation.

Chemical: The most important chemically-induced binder degradations are probably those related to attack by sulfates, alkali-aggregate reaction processes, and leaching of matrix components or immobilised species into neutral or acidic conditions. It has not been possible in any of these scenarios to recommend a single particular test as being the most preferred option for analysis of AAMs, because there are a range of service conditions which must be simulated in the laboratory, and so different tests are required to simulate different service conditions and the corresponding degradation processes.

Transport: The transport-related durability properties of alkali-activated binders depend very strongly on pore structure, which is determined both by binder chemistry and maturity, as well as differences in interfacial transition zone behaviour. The issues of steel corrosion and carbonation in AAM concretes are both critical in determining in-service performance and durability. It appears necessary to validate accelerated testing methods in detail for AAMs by comparison with in-service performance. The details of the chemistry (particularly pore solution chemistry) and microstructure of alkali-activated binders from PC lead to significant differences in the mechanisms which control transport-related durability of these materials, and it is likely that several of the widely-used and standardised testing protocols provide results for these materials which are not fully reliable in predicting long-term performance.

Physical: The use of correlations based on concretes derived from Portland cement and its blends in predicting the performance of alkali-activated concretes is prone to error, as the physicochemical properties of the alkali-activated binder and its interactions with aggregate particles are notably different from those of Portland cement. Important differences are identified as being related to the curing and sample conditioning regimes which are applied prior to testing. More research is needed to fully characterise the mechanical properties of AAM concretes and to more effectively correlate these to each other for use in codes and structural design standards.

There are numerous tangible examples of structures and applications in which alkali-activated concretes have been utilised throughout the past decades. However, there have not yet been a large number of studies of a sufficiently wide range of AAMs exposed under different environmental conditions for decades or more to provide definitive proof of durability performance in service.

The case studies presented in the report display that, in general, the alkali-activated concretes which have been placed into service have been able to serve the purposes for which they were designed, without evident problems related to carbonation, freeze-thaw resistance, mechanical or chemical stability, acid resistance, protection of reinforcing steel, alkali-silica reaction, or any other forms of degradation.

RELATED DOCUMENTS:

1. Provis, J.L. Geopolymers and other alkali activated materials: why, how, and what?. *Mater Struct* **47,** 11–25 (2014).
2. Bernal, S. A. Advances in Near-Neutral Salts Activation of Blast Furnace Slags. *RILEM Tech Lett* **2016,** 1, 39-44.
3. Provis, J.L., Arbi, K., Bernal, S.A. *et al.* RILEM TC 247-DTA round robin test: mix design and reproducibility of compressive strength of alkali-activated concretes. *Mater Struct* **52,** 99 (2019).
4. Winnefeld, F., Gluth, G.J.G., Bernal, S.A. *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).
5. Gluth, G.J.G., Arbi, K., Bernal, S.A. *et al.* RILEM TC 247-DTA round robin test: carbonation and chloride penetration testing of alkali-activated concretes. *Mater Struct* **53**, 21 (2020).

Cluster A
Material Processing and Characterization

Foreword

- from Cluster A Convener,
  Daman K. PANESAR

There are currently eleven RILEM Technical Committees that fall in Cluster A: *Material Processing and Characterization*. These 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. In the last 12 months, TC 267-TRM Tests for reactivity of supplementary cementitious materials completed its activities while two new TCs were established: MCP Accelerated Mineral Carbonation for the production of construction materials and PCC Pumping of concrete.

The specific focus areas of the remaining technical committees include: rheology of cement-based materials (TC 266-RSC); 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 296-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 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
MCP	Accelerated Mineral Carbonation for the production of construction materials	Ruben SNELLINGS	Thomas MATSCHEI	Spring 2022 **NEW!**
PCC	Pumping of concrete	Dimitri FEYS	Geert DE SCHUTTER	Fall 2021 **NEW!**
266-MRP	Measuring Rheological Properties of Cement-based Materials	Mohammed SONEBI	Dimitri FEYS	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
296-ECS	Assessment of electrochemical methods to study corrosion of steel in concrete	Sylvia KESSLER	Ueli ANGST	2020
ADC	Assessment of Additively Manufactured Concrete Materials and Structures	Viktor MECHTCHERINE	Freek BOS	2021
PFC	Performance requirements and testing of fresh printable cement-based materials	Nicolas ROUSSEL	Dirk LOWKE	2021
CNC	Carbon-based nanomaterials for multifunctional cementitious matrices	Florence SANCHEZ	Marco LIEBSCHER	2021

MCP | Accelerated Mineral Carbonation for the production of construction materials

Chair **Ruben SNELLINGS**
Deputy Chair **Thomas MATSCHEI**
Activity started in 2022

Image of demo-site in the city of Ghent, Belgium, showing a footpath of carbonation hardened pavers containing no Portland cement, only milled steel slag and aggregates. Image courtesy of VITO.

Significance

- The conversion of CO_2 into solid, stable mineral carbonates (Mineral carbonation) as a means to produce construction materials is an innovative and rapidly developing field that is expanding in various application domains.
- This process is considered to be a promising and potentially viable way to reduce, store and use carbon emissions.
- As an expanding field, with various research teams breaking ground towards new applications, there is a need for sharing experiences and understanding and develop best practices that build a common knowledge base and disseminate the current state-of-the-art.
- In conjunction, there is a lack of commonly accepted terminology, material characterisation test methods and reliable process impact data and assessments.

Relevance

- R&D in mineral carbonation is interdisciplinary and driven by several scientific communities (e.g. materials science, civil engineering, but also geochemistry, mining and process chemistry). Therefore this TC may be of interest to academic and industrial research groups inside and outside the RILEM community.
- Testing laboratories and policy makers will also benefit from the outcomes of this TC.

Goals

- This TC intends to produce: 1) Terminology and definitions for the rapidly developing field of mineral carbonation; 2) Topical reviews, either as part of an edited volume (STAR book), or as part of a special issue of *Materials and Structures*; and 3) Test method recommendations.
- The TC will organise: 1) One research symposium early on in the life of the TC to gather topical experts and give them the opportunity to present their work. The symposium proceedings are intended to be published as RILEM document; 2) one educational graduate course; and 3) a presentation of the TC progress at various (RILEM) conferences. Towards the end of the life of the TC, the TC results will be presented in a topical session at the RILEM week.

Methodology

- The TC intends to be a platform for topical experts to share experiences and data with the purpose of jointly developing consensus documents that reflect the state-of-the-art in the field, and that can lead to recommendations for material testing methods.
- The TC is supposed to run for 5 years.
- The work will include literature reviewing, exchanging of data, laboratory procedures and best practices, interlaboratory studies.
- Anticipated working group topics are preliminarily structured according to construction material typology: i) Carbonated construction aggregates; ii) Carbonation activated clinkers and SCMs ; iii) CO2 hardened pre-cast products; iv) CO2 cured conventional concrete. an additional working group would cover transversal testing and evaluation methodologies: v) Test and evaluation methods for carbonated construction materials.

Progress

RILEM TC MCP has been approved by the RILEM Technical Activities Committee (TAC) in Spring 2022. Its kick-off meeting is taking place on 21-22 September 2022.

PCC | Pumping of concrete

Chair **Dimitri FEYS**
Deputy Chair **Geert DE SCHUTTER**
Activity started in 2021

Concrete pumping on a small construction site and large-scale concrete pump test on a major construction site. Image courtesy of G. De Schutter.

Significance

- Current international documents on pumping of concrete are substantially aged and need modifications to incorporate the results on modern concrete mixtures.
- With the further development of specialty, flowable and high-performance concrete, this knowledge is crucial to be spread to the industry to maintain the competitive advantage of concrete in the construction industry.
- The need exists to create a State-of-the-art report on pumping of concrete, incorporating the developments made in the last 20 years.
- To the knowledge of the proposers, there is no such document available which includes the latest developments.

Relevance

- The main composition of the group will be academic, but efforts will be conducted to include the industry, in terms of pump producers, material suppliers, contractors and companies producing testing equipment.
- The outcomes of this TC will make academics more aware of the literature available, giving new members in this field a better starting point to study the literature.

Goals

- The work of this TC can generate a report and recommendations similar to the ACI-304 and ACI-211.9 documents, intended to inform the industry on how pumping pressure can be predicted or altered (304) or on how to modify the mix design to make concrete pumpable (211.9).
- The main goal of the committee is the STAR report, for which a first draft is anticipated to be ready in 2025. Based on the STAR, the recommendations could be created in 2026.
- Shotcreting and digital fabrication are not intended to be included in this TC.

Methodology

- The target of the TC is to perform bibliographical research.
- A joint session with ACI 304, 211 and 238 (workability) can be requested for the ACI Spring Convention in New Orleans, LA.
- A workshop could also be organized in Europe near the closure of the committee

Progress

RILEM TC PCC has been approved by the RILEM Technical Activities Committee (TAC) in Fall 2021 and its kick-off meeting took place online on 14 March 2022.

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

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

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.

Progress

- General Committee meetings in the last 12 months: 1st October 2021 and 4th February 2022 (online).
- Round Robin Test online meetings: 7th Oct 2021, 19th Jan 19, 5th Feb, 15th Feb 2022.

Round Robin Test on rheology of cement-based materials in Bethune (France), 28-30 May 2018. Image courtesy of M. Sonebi.

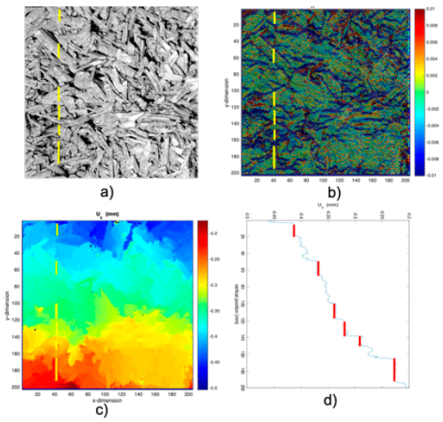
- 4 papers for topical collection in *Materials and Structures* are planned to be finalised by 2022.
- Paper on "oscillatory rheological measurements" to be submitted to *RILEM Technical Letter* by 2022.
- STAR hopefully finalised in 2022.
- Presentation of TC outcomes planned in September 2022 at the 76th RILEM Annual Week.

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

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

Significance

The preservation of the environment is one of the principal features of sustainable development. 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.



Vegetal aggregate participation:
a) picture of hemp concrete of the RRT;
b) superposition with vertical strain;
c) vertical displacement field;
d) section along the yellow line.
Image courtesy of É. Toussaint.

Progress

- 4 online meetings held between May 2021 and April 2022.
- Planning to publish in *Materials and Structures* a topical collection of 4/5 articles addressing the following topics: 1) RRT-Overview and objectives; 2) RRT – moisture buffer value of vegetal concrete; 3) RRT - Water Vapour Permeability; 4) RRT-capillary of vegetal concrete; 5) RRT-thermal conductivity hemp concrete;
- TC progress as scheduled for RRT1- hygrothermal studies; RRT2- durability delayed and reduced due to COVID.
- Presentation of TC outcomes planned in September 2022 at the 76th RILEM Annual Week in Kyoto, Japan.
- Organisation of special session during RILEM conference Synercrete 2023 in Milo, Greece.
- Organisation of ICBBM 2023 at TU Wien from 21 to 23 June 2023.

282-CCL | Calcined clays as supplementary cementitious Materials

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

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.

Progress

- Topical Collection "Calcined Clays as Supplementary Cementitious Materials" in *Materials and Structures*, containing the following papers:

  - Snellings, R., Almenares Reyes, R., Hanein, T. *et al.* Paper of RILEM TC 282-CCL: mineralogical characterization methods for clay resources intended for use as supplementary cementitious material. *Mater Struct* **55**, 149 (2022).

  - Dhandapani, Y., Joseph, S., Geddes, D.A. *et al.* Fresh properties of concrete containing calcined clays: a review by RILEM TC-282 CCL. *Mater Struct* **55**, 151 (2022).

  - Dhandapani, Y., Joseph, S., Bishnoi, S. *et al.* Durability performance of binary and ternary blended cementitious systems with calcined clay: a RILEM TC 282 CCL review. *Mater Struct* **55**, 145 (2022).

  - Hanein, T., Thienel, KC., Zunino, F. *et al.* Clay calcination technology: state-of-the-art review by the RILEM TC 282-CCL. *Mater Struct* **55**, 3 (2022).

  - Alujas Diaz, A., Almenares Reyes, R.S., Hanein, T. *et al.* Properties and occurrence of clay resources for use as supplementary cementitious materials: a paper of RILEM TC 282-CCL. *Mater Struct* **55**, 139 (2022).

Some examples of common kaolinitization environments: a) Kaolinite vein due to hydrothermal alteration of rhyolites (eastern region, Cuba). b) Sampling trench in redeposited clay deposits (plains in western region, Cuba). c) Weathering crust over gabbros (eastern region, Cuba). *Materials and Structures* (2022) 55:139.

- Two more papers shall be submitted to *Materials and Structures* as part of the Topical collection, and three more papers will be circulated for approval before December 2022. Process of paper preparation is in parallel responding to industry issues/questions warranted for implementing CCL in practice.
- International Conference on Calcined Clays for Sustainable Concrete 2022, 5-7 July 2022, Swisstech Convention Center – Lausanne, Switzerland.

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

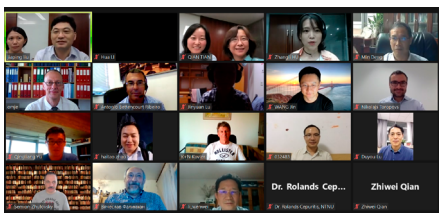
Chair **Jiaping LIU**
Deputy Chair **Ole Mejlhede JENSEN**
Activity started in 2018

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.

Progress

- Last (4th) annual TC meeting held online in September 2021. Next (5th) annual TC meeting in September 2022, at the 76th RILEM Annual Week.
- Draft of STAR "Properties and engineering application of MgO concrete" to be completed in 2022.
- RRT on hydration reactivity, restraint expansion of MEA – under preparation.
- Guidelines for the quality control of MgO expansive agent (planned to be completed 2023).



Group photo of members of TC 284-CEC attending the 4th TC in September 2021. Image courtesy of TC 284-CEC.

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

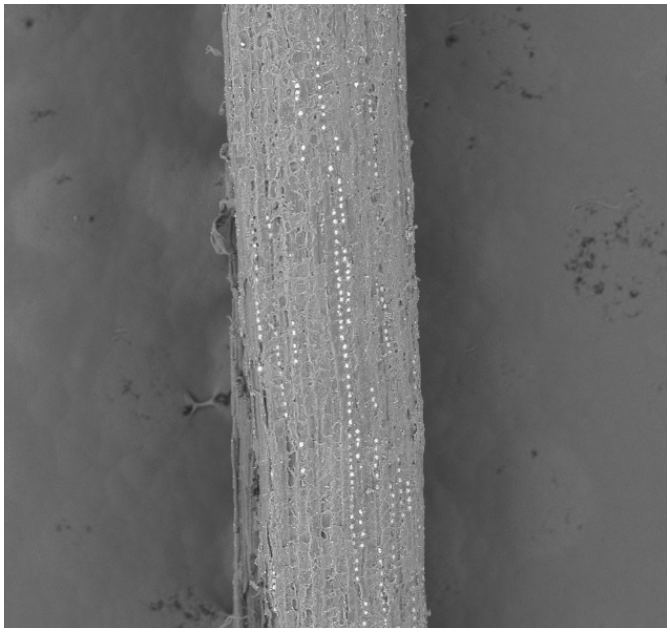
Chair **Said KENAI**
Deputy Chair **Mike OTIENO**
Activity started in 2018

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.

Progress

- STAR expected to be finalized by Feb 2023.
- Some TC members met in person in Dec 2021 in Accra, Ghana.
- A Workshop is planned in Dakar, Senegal, in Dec 2022.
- Online workshop was held in Jan 2021 Chaired by Wolfram Schmidt & Kolawole Olonade.
- Several zoom meetings between authors of the STAR chapters were held in 2022 (June 16th, May 3rd, April 28th, April 21th).



Microscope image of untreated coconut fibre. Image courtesy of O. Kolawole.

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

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

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.

Progress

- The kick-off meeting of this TC was held in Feb 2021. Other online meetings followed in June, Nov 2021 and in March 2022.

Damage produced by the corrosion of the steel reinforcement in concrete elements. Images courtesy of U. Angst.

- Other TC meetings are scheduled for 2022.
- Expected RILEM Week presentation in 2024.
- Task groups are working on drafting TC documents.

ADC | Assessment of additively manufactured concrete materials and structures

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

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.

Progress

- Kick-off meeting held online in April 2021.
- In Oct 2021 an online workshop was scheduled to organize the TC manuscripts.

Flyer of the 3rd RILEM International Conference on Digital Fabrication with Concrete.

- In Nov 2021 a hybrid meeting was held in Dresden, Germany.
- Other TC meetings are scheduled in 2022, amongst which the one in June in Loughborough, UK, for the 3rd RILEM International Conference on Digital Fabrication with Concrete (Digital Concrete 2022). The proceedings published by Springer are available here.
- The TC is preparing two extensive interlaboratory studies, on the mechanical properties and durability of printed concrete.

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

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

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.
Fresh material must initially remain fluid enough to facilitate deposition and inter-layer bonding, but materials that are too fluid can lead to buckling and collapse of structures.
The importance of these mechanisms has driven significant efforts in: determining the rheological requirements of the fresh material; quantifying buildability; and predicting structural failure for controlling deformation behaviours.
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.

Delegates of the 3rd RILEM International Conference on Digital Fabrication with Concrete. Image courtesy of R. Buswell.

Progress

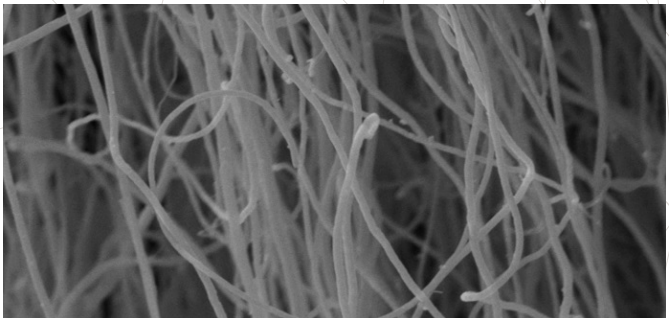
- Online Workshop held in June 2021; a second workshop is scheduled in 2022.
- Second TC general meeting held in November 2021, in Dresden, Germany.
- One of the TC meetings was help in June 2022 in Loughborough, UK, for the 3rd RILEM International Conference on Digital Fabrication with Concrete (Digital Concrete 2022). The proceedings published by Springer are available here.

CNC | Carbon-based nanomaterials for multifunctional cementitious matrices

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

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.



Electron micrograph of entangled Multi-Walled Carbon Nanotubes. Image courtesy of M. Liebscher.

Progress

- Kickoff Meeting held in Sept 2021.
- Second TC general meeting in April 2022.
- WG2 “hardened properties” met online in Jan 2022.
- WG3 “smart properties” met online in Nov 2021 and Feb 2022.

Cluster B

Transport and Deterioration Mechanisms

Foreword

- from Cluster B Convener,
  Josee DUCHESNE

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 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. These technical committees are related mainly to cement based materials, pastes, mortars, and concretes. Between 2005 and 2022, 24 Technical Committees have been created under Cluster B.

Currently, Cluster B has 7 active TCs, related with different aspects of traditional and novel construction materials, their properties, and the durability behaviour. During the last TAC meetings, in Fall 2021 and Spring 2022, no new TCs have been established under Cluster B; TC 262-SCI "*Characteristics of the steel/concrete interface and their effect on initiation of chloride induced reinforcement corrosion*" completed its activities during the last 12 months and it is now closed.

Current TCs in Cluster B

Code	Title	Chair	Deputy Chair	TC opened in
281-CCC	Carbonation of concrete with supplementary cementitious materials	Nele DE BELIE	Susan A. 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
297-DOC	Degradation of organic coating materials and its relation to concrete durability	Takafumi NOGUCHI	Kei-Ichi IMAMOTO	2020
298-EBD	Test methods to evaluate durability of blended cement pastes against deleterious ions	William WILSON	Prannoy SURANENI	2020
FTC	Durability and Service Life of Concrete under the Influence of Freeze-Thaw Cycles combined with Chloride Penetration	Erik SCHLANGEN	Peng ZHANG	2018

281-CCC | Carbonation of concrete with supplementary cementitious materials

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

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.

Progress

- Vanoutrive, H., Van den Heede, P., Alderete, N. *et al.* Report of RILEM TC 281-CCC: outcomes of a round robin on the resistance to accelerated carbonation of Portland, Portland-fly ash and blast-furnace blended cements. *Mater Struct* 55, 99 (2022).
- Last TC 2-day workshop held 9-10 June 2022 (in person in Ghent + online) – 39 participants, 19 lectures.
- WG1 and WG2 preparing a paper on "Inter-lab test – accelerated versus natural carbonation" (13 labs).

Members of the TC 281-CCC at the 2-day TC workshop in Ghent, Belgium, in June 2022. Image courtesy of N. De Belie.

- WG3 finalising work on survey of carbonation models - development of a database.
- WG4 working on developing test setups + interlab test - carbonation combined with mechanical loads. A second round of interlab tests has been completed. A paper on the test series is being drafted.
- WG6 – Dissemination of constructed database on concrete based on blended cements with a high volume of SCM including alkali activated concrete. A paper is currently under review of *Materials and Structures*.

283-CAM | Chloride transport in alkali-activated materials

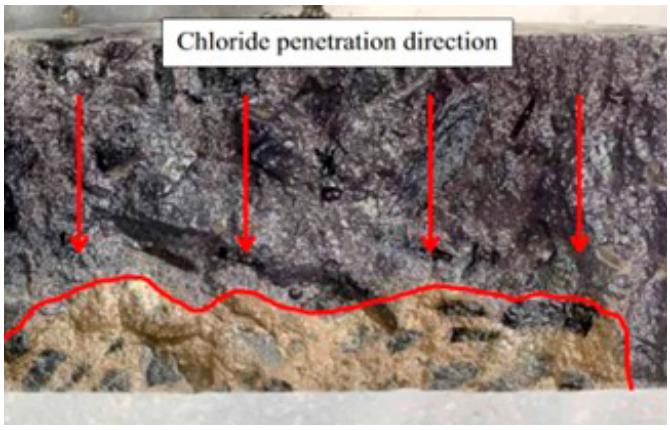
Chair **Arnaud CASTEL**
Deputy Chair **Shishir MUNDRA**
Activity started in 2018

Significance

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

Progress

- TC-283-CAM is mostly lab experimentation based. Covid 19 has delaying/postponing TC progress.
- Planning an in person general TC meeting in September 2022, for the 76th RILEM Annual Week, Japan.
- Consolidated set of laboratories working in WG1 "Performance based specifications for AAMs": LMDC Toulouse, France; UNSW, Australia; RMIT, Australia; UTS, Australia.



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

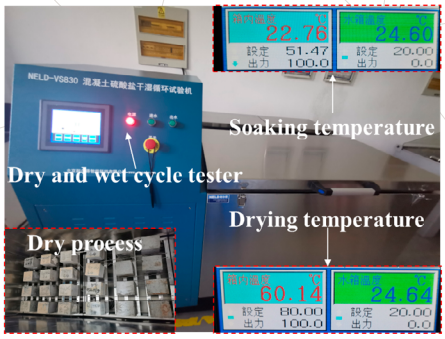
- Consolidated set of laboratories working in WG2 "Chloride binding capacity of AAMs and chloride diffusion modelling.": BAM, Germany, ETH Zürich, Switzerland.

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

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.



Concrete specimen exposed to solution of sulfate and chloride ions. Image courtesy of Mu Song.

Progress

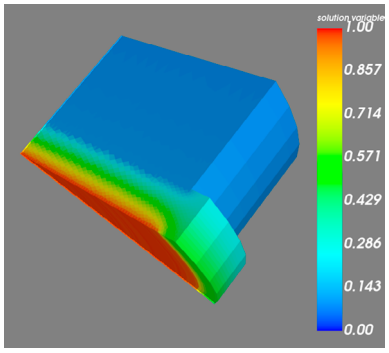
- Progress of laboratory and field experiments were delayed due to COVID pandemic.
- One or two TC general meetings in 2021. A workshop is planned in October 2022.
- Paper on 'Laboratory and field evaluations of concrete under the coupling action of sulphate and chloride' is in the pipeline, to be submitted to *Materials and Structures*.
- Currently drafting State-of-the-Art Report and updating literature review on degradation mechanisms of cement-based materials.
- Ongoing pioneering laboratory experiments: compare the effect of cementitious material on sulphate resistance of concrete; three series: 1) OPC; 2) OPC with SCM; 3) OPC with SCM and chemical admixtures. Field Exposure Test: Zhangye (semi-buried – dry, strong wind, saline soils).

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

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

Significance

Rebar corrosion and other detrimental phenomena for concrete are linked to oxygen, carbon dioxide and water vapor 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.



3D - Oxygen concentration map during a diffusion test to illustrate transient effect in sample and in downstream volume as well as side effects because of sealing joints. This work contributes to defining the right analytical solution for interpreting gas diffusion test results. Image courtesy of B. Huet.

Progress

- STAR under development. It will consist of 9 chapters. Each chapter will also be a paper to be presented in a *Materials and Structures* topical collection. The chapters outline is: chapter 1: "Diffusion mechanisms"; chapter 2: "Diffusion sets up and procedures": writing well advanced; chapter 3: "Gas diffusion in cement materials"; chapter 4: "Gas diffusion in other porous materials"; chapter 5: "Carbonation assessment of cement-based materials with gas diffusion"; chapter 6: "Corrosion and Oxygen diffusion"; chapter 7: "Modeling moisture transport in porous media"; chapter 8: "Radon diffusion in buildings materials"; chapter 9: "Modeling gas diffusion in porous media".
- Laboratories involved in the Inter-laboratory tests (benchmark): Imperial College-UK, EMPA-Switzerland, Holcim Innovation Center-France, LaSIE-France, CEA-France, TU Darmstadt-Germany, SCK CEN-Belgium, IETCC-Spain, University Alicante-Spain.
- Analytic method proposed to determine the diffusion coefficient is under development; 1D and 2D axisymmetric simulations of real geometries with CEA-France, LaSIE-France, SCK CEN-Belgium, Holcim Innovation Center-France, RWTH-Germany.

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

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

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 CO_2 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.

Progress

- A special session will be organized during the 76th RILEM Annual Week 2022 and International Conference on Regeneration and Conservation of Structures (ICRCS 2022), in Kyoto, Japan.

Technician spraying a waterproofing organic coating layer on a concrete roof. Image courtesy of Creamer Media.

- Ongoing work on drafting of STAR "Degradation of protective surface treatment and its relation to concrete durability". Tentative table of content is:

1) Preface: What is problem? What is solution?
2) Guidelines regarding organic coating material effect on durability of concrete
3) Deterioration mechanisms of organic coating materials
4) Field survey on deterioration of organic coating materials and its relation to concrete durability
5) Maintenance of organic coating material
6) Test method to evaluate degradation of coatings in Lab. and on-site
7) Conclusions and future overview.

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

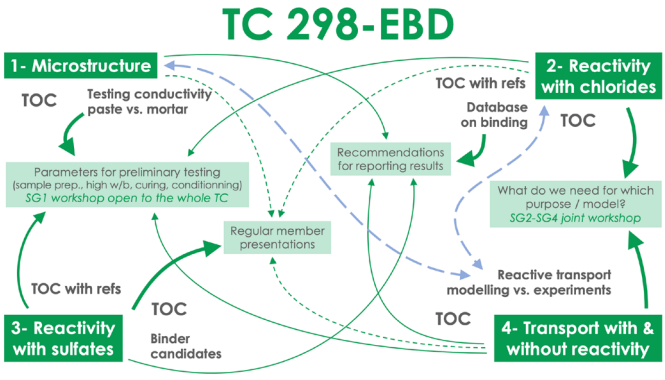
Chair **William WILSON**
Deputy Chair **Prannoy SURANENI**
Activity started in 2020

Significance

The CO_2 reduction targets of the cement industry necessitate the development of 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 on long-term concrete durability. As long-term concrete durability tests are laborious and time consuming, this TC focusses on paste-level durability tests for chloride and sulfate.

Progress

- Many online meetings of the entire TC and of working groups held since the establishment of the TC. A first in-person meeting is planned in 2022/2023.
- Drafts of journal publications and reports are in progress. First ones to be submitted in late 2022.
- Analysis of data from literature is ongoing.



Schematics of the working programme of TC 298-EBD. Image courtesy of W.Wilson.

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

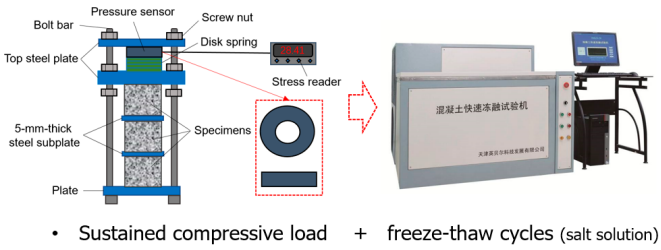
Chair **Erik SCHLANGEN**
Deputy Chair **Peng ZHANG**
Activity started in 2018

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.

Progress

- A comprehensive literature review is established.
- The first results of the comparative test series have been discussed. The guidelines for the test series were specified in more details and more laboratories engaged 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.
- The experimental results shall be summarized for publication soon.



Schematics of the experimental process (sustained compressive load and freeze-thaw cycles) adopted by TC FTC. Image courtesy of P. Zhang.

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 (294-MPA); in Spring 2022 two new TCs have been approved, working on: i) concrete during fire (CFR) and ii)on-site corrosion assessment (OCM).

Structural behaviour should be supported by reliable numerical models that are particularly useful for better understanding structural performance as well as 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 "1*75-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.

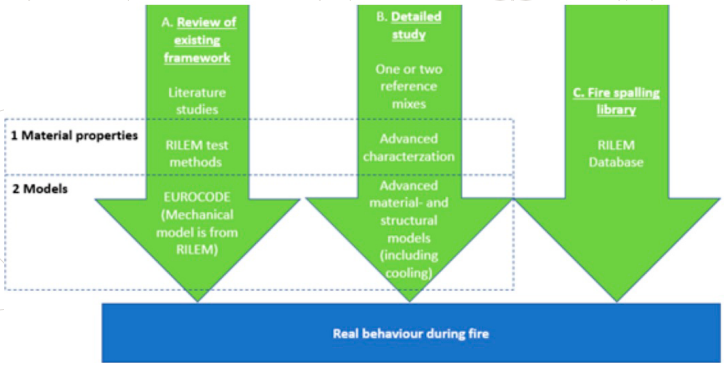
The first recommendation published by this Cluster dates back to 1997, "*Recommendations of RILEM TC 178-TMC: 'Testing and modelling chloride penetration in concrete' Analysis of water soluble chloride content in concrete*". Five more recommendations and seven state-of-the-art-reports (STARs) have been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

Current TCs in Cluster C

Code	Title	Chair	Deputy Chair	TC opened in
CFR	Concrete during Fire - Reassessment of the framework	Pierre PIMIENTA	Robert JANSSON MC NAMEE	Spring 2022 **NEW!**
OCM	On-site Corrosion Condition Assessment, Monitoring and Prediction	Carmen ANDRADE	Pedro CASTRO BORGES	Spring 2022 **NEW!**
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 A. D. 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
294-MPA	Mechanical properties of alkali-activated concrete	Guang YE	Frank DEHN	2019

CFR | Concrete during Fire - Reassessment of the framework

Chair **Pierre PIMIENTA**
Deputy Chair **Robert JANSSON MC NAMEE**
Activity started in 2022



Provisional timetable	1st year	2nd year	3rd year	4th year	5th year
Task A - Review of existing framework					
Task A1 - Literature review					
Task A2 - Literature review					
Task A3 - Numerical investigations					
Task A - Summary and conclusions					
Task B - Detailed study of 2 mixes					
Task B1 - Definition of Mixtures					
Task B2 - Additional experiments					
Task B3 - Advanced numerical investigations					
Task C - Fire spalling library					
Task C1 - Definition of the database					
Task C2 - Collecting data					
Task C3 - Synthesis					

On the top: illustration of the 3 tasks of the TC. On the right: provisional timetable of the activities of TC CFR. Image courtesy of TC CFR.

Significance

- Different RILEM committees have worked with concrete at high temperature for several decades. The topics have varied from material science, modelling, and behaviour of structures. Findings from this committees have been summarised in recommendation and STARs and parts are included in the Eurocode 2 Part 1-2. Despite this extensive work, no real assessment of the whole framework have been done. This is the topic of the new committee.
- Task A of the committee is to review the existing framework based on the Eurocode regarding prediction of real behaviour of concrete elements and structures during fire exposure.
- Task B of the committee is to make a detailed study of one or two reference mixes from material characterization and modelling to real behaviour during fire exposure using the best available methods and modelling tools.
- Task C of the committee is to create a database with fire spalling of concrete test results. This is an important complement to the other tasks as the occurrence of fire spalling have the potential to dramatically alter the fire resistance of structures.

Relevance

- The work undertaken by this TC will especially target: Universities and testing laboratories; Material scientists and experts; Designers and civil engineers; Building material companies and industries; Building and infrastructure authorities; Standardisation bodies.
- Results will contribute to the development of performance-based design of concrete structures under fire. They will increase the reliability of the design framework (and extend the framework to concrete used in practice today). This would help to achieve more economical structural design against fire.
- Results will allow improvement in the understanding of the academic community (main mechanism, experiments, modelling, …).

Goals

- Conducting a re-assessment of the existing framework for assessing concrete under fire, from material behaviour to real structural behaviour. This also includes the creation of a RILEM database for fire spalling test results.

Methodology

- The TC organization will be based on parallel working groups (WG) corresponding to the 3 tasks A to C and sub-tasks, ad illustrated in the figures above.
- Members of the new TC can take part and contribute to more than one WG.
- Two annual meetings (2 days) will be organized.

Progress

This TC was approved in Fall 2022 and a first kick-off meeting was arranged in Paris July 7-8. During the meeting 18 participants developed the different tasks in detail and a one-hour online session was arranged to get input from additional 6 participants.

OCM | On-site Corrosion Condition Assessment, Monitoring and Prediction

Chair **Carmen ANDRADE**
Deputy Chair **Pedro CASTRO BORGES**
Activity started in 2022

Corrosion damage in structural elements of transport infrastructure made of reinforced concrete. Images courtesy of C. Andrade.

Significance

- Reinforcement corrosion is one of the major causes of the deterioration of structural concrete. Nevertheless, its assessment in real structures still lacks standardized procedures.
- A comprehensive approach for the corrosion condition assessment has not been found yet. A procedure of the implementation of this approach into the actual trend is also missing.
- The prediction of evolution of the corrosion in different environments and the calculation of the remaining life until the ad-hoc structural limit state are not contained in present Codes. A gap exists which needs pre-normative documents which could be used to gain experience with the aim to have rules incorporated into the future structural codes.

Relevance

- The outcome of this TC will be of interest for practitioners and designers.
- It will be as well for academics and those organizations related to standards related to existing structures. However, the most direct end users will be engineers of maintenance, consultants, inspectors and structural engineers.

Goals

- To review and update the previous Rilem Recommendations on electrochemical techniques and on chloride analysis.
- To add new information or complement it with new on-site testing methods.
- To develop a general evaluation procedure for the combined consideration of all the information in order to make a comprehensive diagnostic related to corrosion level and present condition of the structure regarding its service life.
- To integrate the data from monitoring and this general procedure.

Methodology

- The work is foreseen for a maximum of 4 years: the optimum would be 3 years plus 1 or 2 for the editorial work.
- The work has a practical relevance as the TC will deal with site methods.
- In 2022, the TC will organize a Workshop for sharing the knowledge on the subject and discussing previous case studies of monitoring and site inspections. Proceedings will be published.
- In 2023, the work on the Deliverables will continue by virtual meetings.
- In 2024, the same pattern of work is foreseen unless otherwise is decided.

Progress

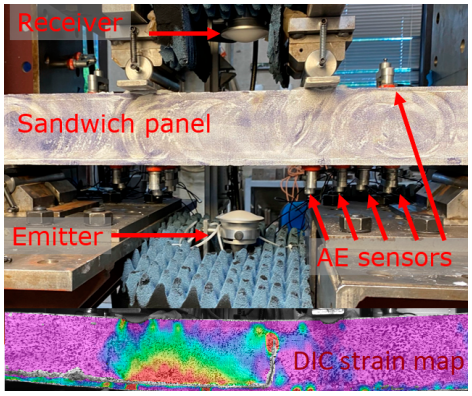
The TC was approved by TAC during the Spring meeting in 2022. A kick-off meeting is planned to be held soon.

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

Significance

Worldwide infrastructure is aging. By 2030 more than half of road and bridges will be older than 50 years. 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.



Experimental set up of a 4-point bending test and monitoring equipment to assess the damage of the sample during the test. Image courtesy of D. Angelis.

Progress

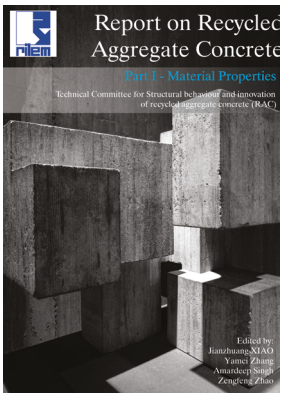
- Two more general TC meeting held in 2022 (in April, virtual mode, and in June, in person at the Royal Society of Edinburgh, UK).
- A relevant lecture on this topic will be given within the RILEM EAC PhD course at the 76th RILEM Annual Week in Kyoto, Japan, in Sep. 2022.
- Presentation of TC outcomes planned in September 2022 at the 76th RILEM Annual Week.
- RILEM Recommendations will be published in *Materials and Structures*.
- A special issue is being established in the international journal "Developments in the Built Environment".

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

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

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.



Part I (of three) of the STAR in preparation by TC 273-RAC. Image courtesy of TC 273-RAC.

Progress

- Presentation of TC outcomes planned in September 2022 at the 76th RILEM Annual Week.
- Revision of three parts of TC STAR is under progress:

- Part A, "Report on Recycled Aggregate Concrete material properties" has the following outline: Chapter 1: Properties of recycled aggregates and related specifications; Chapter 2: New technology to improve the properties of Recycled Aggregate Concrete; Chapter 3: Mix proportion design method of RAC and properties of fresh RA; Chapter 4: Constitutive relationships of Recycled Aggregate Concrete; Chapter 5: Long-term properties of RAC and its product.

- Part B, "Report on Recycled Aggregate Concrete Structural performance" has the following outline: Chapter 1: Recycled aggregate concrete for building structures; Chapter 2: Recycled aggregate concrete bond behavior; Chapter 3: Recycled aggregate concrete components: Beams, Columns, Shear walls and Slabs; Chapter 4: Seismic performance of concrete with RA; Chapter 5: Case studies in structural RAC; Chapter 6: Structural health monitoring and numerical simulation models for practical design ; Chapter 7: Long-term performance of reinforced RAC components.

- Part C, "Standards and Specifications of RA and/or RAC".

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

Chair **Miguel A. D. AZENHA**
Deputy Chair **Fragkoulis KANAVARIS**
Activity started in 2019

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

Progress

- Conference proceedings of the International RILEM Conference on Early-Age and Long-Term Cracking in RC Structures - CRC 2021; Eds. F. Kanavaris, F. Benboudjema, M. Azenha; Vol. 31, Springer.
- Azenha, M., Kanavaris, F., Schlicke, D. *et al.* Recommendations of RILEM TC 287-CCS: thermo-chemo-mechanical modelling of massive concrete structures towards cracking risk assessment. *Mater Struct* **54**, 135 (2021)
- TC 287-CCS book on crack width analysis steadily progressing with chapters being formulated.
- TC 287-CCS specialist studies currently under assessment for publication.
- TC 287-CCS is attracting interest from both academia and industry and the number of participants is steadily growing.

Recent outcomes of the work of TC 287-CCS: proceedings of the conference on Early-Age and Long-Term Cracking in RC Structures- CRC 2021. Image courtesy of Springer.

288-IEC | Impact and explosion

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

Significance

In the framework of impact and explosion, there are many specific experimental devices all over the world, which have never been thoroughly compared and connected. There is the need to develop a stronger link between the worldwide existing experimental laboratories that have specific devices, often not fully used. 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. In the two following years, the Committee will achieve the last three main objectives.

Progress

- Two TC meetings held in 2021 (September and December).
- Final draft of Fib bulletin as framework reference of the Model Code 2020 ready in June 2022. The table of content is the following:

1. Introduction; 2. Type of analyses; 3. Material properties; 4. Evaluation of structural initial and residual bearing capacity; 5. Structural design strategies to improve the bearing capacity; 6. Classification for weak impact and blast protection barriers; Annex. Definitions and symbols.

Intense explosion on a military ground. Image courtesy of J. Kingma.

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

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

Significance

Textile reinforced concrete (TRC) materials are lightweight, ductile, strong, and have the potential to be used as structural components taking tensile, flexural, cyclic and impact loads. The advancements in the textile technology specifically directed at their use in cement-based materials has led to composites with an order of magnitude higher in strength and two orders of magnitude higher in ductility than fiber reinforced concrete (FRC). This also provides an excellent opportunity as repair materials. The common areas of application of TRC, such as ultra-high performance concrete, UHPC, 3D printing, FRCM and repair of infrastructure to mention a few, are in urgent need to develop and implement design tools and applications for strain hardening cement composites.

Progress

- A TC meeting and special session on TRC is expected during the CICE 2023 conference.

Carbon reinforced concrete house CUBE in Dresden, Germany. Image courtesy of S. Gröschel.

- A special session on TRC is planned for the ACI Convention in Boston from October 29th until November 2nd, 2023.
- A TC face-to-face meeting is expected during the Rilem Spring Convention in Milano, Italy, in 2024.
- RILEM TC STAR on Textile Reinforced Concrete (TRC) is moving forward: WG1 "Materials and Materials System": three chapters of STAR developed and currently being proofread; WG5 "Durability and sustainability": one STAR chapter completed; WG2 "Constitutive Modelling", WG3 "New Elements", and WG4 "Repair and Retrofitting": Literature Review documents are under development.

294- MPA | Mechanical properties of alkali-activated materials

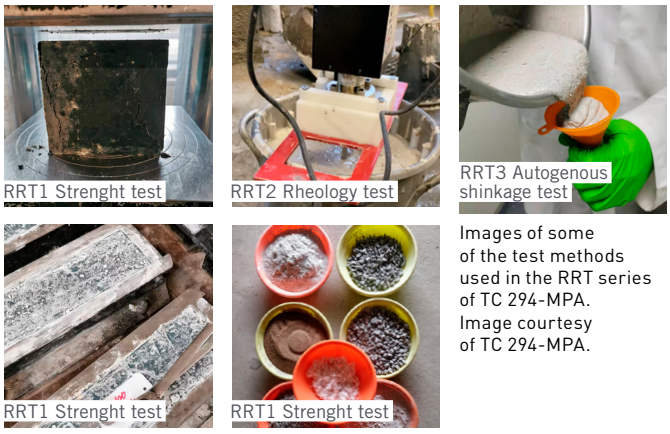
Chair **Guang YE**
Deputy Chair **Frank DEHN**
Activity started in 2019

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.

Progress

- Table of content of TC STAR has been discussed and the responsible author for each chapter assigned. The STAR outline is the following: PART I: General Issues; Part II: Chemistry and mix design; Part III: Fresh and hardened AAM Properties; Part IV: Volume stability and cracking potential; Part V: Standardization and application.
- Tentative date of completion of STAR is December 2023.
- Experiments of RRT have started to assess if current test methods for mechanical properties of conventional concrete are applicable and repeatable on AAM mixtures, and to provide reasonable and reliable mechanical properties of AAMs for structural design and for constitutive law.
- RRT experiments are expected to complete in December 2022.



Images of some of the test methods used in the RRT series of TC 294-MPA. Image courtesy of TC 294-MPA.

Cluster D

Service Life and Environmental Impact Assessment

Foreword

- from Cluster D Convener,
  Anya VOLLPRACHT

Cluster D coordinates the activities of the Technical Committees (TCs) dealing with "Service life" and "environmental impact" of structures, mainly reinforced concrete structures. Currently, Cluster D comprises six TCs. In the last 12 months, TC 270-CIM Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice finalised its activities and TC DCS Data-driven concrete science was added as a new TC. One major topic in Cluster D is alkali-silica reaction (ASR), which is explored in two committees from different perspectives (TC 300-ARM and TC 301-ASR). Other service life aspects are stress corrosion and hydrogen embrittlement (TC 293-CCH) and the durability of marine structures (TC 289-DCM). With respect to the environmental issues, the TC 299-TES is investigating different methods to store thermal energy in order to improve the energy efficiency of buildings.

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, 26 TCs have worked under the coordination of the convener of Cluster D, a title that I have the honour to hold since September 2021. I took over the role previously filled by Dr Alexandra Bertron.

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 and at least four STARs are under preparation or nearly finalised. In addition, numerous journal papers and conference contributions are planned to transfer the knowledge and increase the visibility of RILEM.

Current TCs in Cluster D

Code	Title	Chair	Deputy Chair	TC opened in
DCS	Data-driven concrete science	Sandra NUNES	Moncef NEHDI	Spring 2022 **NEW!**
289-DCM	Long-term durability of structural concretes in marine exposure conditions	Kefei LI	Junjie ZENG	2019
293-CCH	Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete-Reinforcing Steels	Javier SANCHEZ MONTERO	Alvaro RIDRUEJO	2016
299-TES	Thermal energy storage in cementitious composites	Jorge SÁNCHEZ DOLADO	Antonio CAGGIANO	2020
300-ARM	Alkali-aggregate reaction mitigation	Esperanza MENENDEZ MENDEZ	Leandro SANCHEZ	2020
301-ASR	Risk assessment of concrete mixture designs with alkali-silica reactive (ASR) aggregates	Jason H. IDEKER	Klaartje DE WEERDT	2020

DCS | Data-driven concrete science

Chair **Sandra NUNES**
Deputy Chair **Moncef NEHDI**
Activity started in 2022

Significance

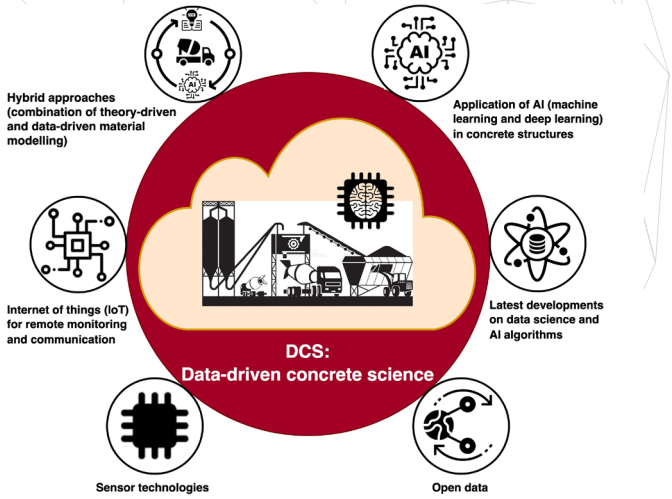
The concrete industry is increasingly in need of intelligent tools to further develop and use concrete in important structures. It also needs more advanced simulation tools for concrete performance validation and uncertainty quantification. Such requirements are well aligned with recent developments in data-driven models based on artificial intelligence (AI). Data-driven models can help bring accuracy in areas where "real life" varies significantly from "model or idealized", thus bridging gaps in basic understanding. AI techniques require robust and comprehensive data sets for training and validation. Hence, a better use of existing data, as well as the availability of more structured and validated information of the materials and components, are essential for the ability to reliably simulate options and make sound decisions. Open data sharing among the concrete research community is still in its infancy. To ensure that it matures into widespread practice actions at various levels are required.

Relevance

- The main composition of the TC group will be academic, but efforts will be made to include pertinent industry (concrete producers, materials suppliers, companies producing sensors,…) and governmental institutions (research centers, standard issuing entities, etc.).
- The targeted users are researchers, Ph.D. students, practitioners, and industry experts in the field of concrete materials and structures.

Goals

- To gather, analyse and present the state-of-the-art in a report on the use of AI algorithms (machine learning and deep learning) in concrete structures.
- To create a STAR report on the use of AI in concrete structures, for which a first draft is anticipated to be ready in 2027.



Schematics of the work programme of TC DCS.
Image courtesy of W. Taffese.

- To propose best practices and recommended formats for data. Based on the STAR, the recommendations could be created in 2028.

Methodology

- No experimental work will be done, and nor will new equipment be developed.
- The work of this committee is based on surveying the pertinent literature and experiences gained by the committee members.
- The following topics are intended to be included: 1) Latest developments on data-science and AI algorithms; 2) Application of machine learning and deep learning in concrete structures; 3) Hybrid approaches (combination of theory-driven and data-driven material modelling); 4) Recent advances in sensor technologies (target: to collect data); 5) Internet of things (IoT) for remote monitoring and communication; 6) Open data.

Progress

This TC was approved in Spring 2022 and its kick-off meeting will occur in Fall 2022.

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

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

Significance

Data collection from exposure stations is rather intuitive, and a systematic format for data collection/presentation is 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.

Progress

- TC meetings over the last 12 months: 30 August 2021 (22 participants), 20 December 2021 (12 participants) and 13 February 2022.

Exposure site in Cayo Santa-Maria, Cuba. Image courtesy of J. F. Martirena Hernández.

- 1 review paper "Long term field exposure of structural concretes in marine environment: state-of-the-art review" is submitted to *Materials and Structures*.
- Accumulation of dataset will be continued and uploaded into the electronic form-based database.
- Plans for future activities: drafting of the technical guideline.

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

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

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. Over the last years, the advent of new modelling tools 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.

Steel sample that has suffered hydrogen embrittlement. Image courtesy of J. Sanchez Montero.

Progress

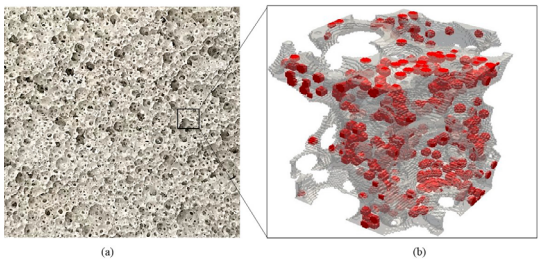
- Drafting of STAR is progressing (about 100% of completion). The outline will be the following: 1. Introduction; 2. Stress corrosion cracking of construction steel; 3. Hydrogen Embrittlement of construction steel; 4. Reference standards; 5. Case studies; 6. Concluding remarks.
- Workshop on Stress Corrosion Cracking and Hydrogen Embrittlement of Concrete Reinforcing Steels held online from 15 to 16 November 2021.
- Final presentation of TC at the 77th Annual Week, Vancouver, Canada, in 2023.

299-TES | Thermal energy storage in cementitious composites

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

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.



(a) Porous cementitious system enhanced with PCM and (b) 3D numerical schematization. Images courtesy of A. Caggiano and I. Peralta.

Progress

- Working groups have been defined: WG1: SHS: Experimental part; WG2: SHS: Modelling part; WG3: LHS: Experimental part; WG4: LHS: Modelling part; WG5: TCS: Experimental part; WG6: TCS: Modelling part.
- RILEM STAR on cementitious TES devices: 8 chapters planned, leaders assigned, tentative complete first version by end of 2022.
- Round robin tests have been launched: specimens for RRT have been prepared and send out. DSC measurements are being performed.

300-ARM | Alkali-aggregate reaction mitigation

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

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 damage. 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.

Dam of Santa Luzia and Pracana affected by ASR. Technical visit of ICAAR – Lisbon, June 2022. Image courtesy of I. Fernandes.

Progress

- Working groups have been defined:
  - WP1 – Strategies to mitigate AAR in affected concrete structures – literature review
  - WP2 – Non-traditional mitigation materials/products in fresh and hardened concrete
  - WP3 – Test procedures and strategies to evaluate non-traditional mitigation products in new and affected concrete
  - WP4 – Coordination between the 3 WPs to produce a STAR.
- Special session organised at the 6th International Conference on Concrete Repair, Rehabilitation and Retrofitting - ICCRRR 2022.

301-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

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.

Progress

- Working groups have been defined:
  - WP1 – Validation (determination of the uncertainty) of selected accelerated performance-based test methods
  - WP2 – Impact of the different alkali sources on reactivity and prevention
  - WP3 – Risk assessment of concrete mixture designs with ASR aggregates (based on data from WP1&WP2).
- WP 1 decided to merge two of their Task Groups so that a better focused group could be formed with clear tasks and outcomes.
- WP 2 also decided to merge two of their task groups to better accomplish their goals and to bring clarity to two tasks that were interrelated.
- WP 3 had an excellent discussion that helped to better refine the goal and structure of the proposed framework/ model. This provided better guidance for the type and structure of data that WP 1 and 2 will feed into WP 3.
- WP 3 has defined the topic and structure of their review paper dealing with bridging the gap between real questions from practitioners and possible solutions from modelers.
- A STAR is planned.
- TC 301-ASR main meeting, as well as 1.5 hour WP 1, 2, and 3 meetings were held on Monday 31 May during ICAAR 2022 – Lisbon, Portugal.

TC 301-ASR members at the ICAAR Conference in Lisbon, Portugal, in June 2022. Image courtesy of K. De Weerdt.

Cluster E Masonry
Timber and Cultural Heritage

Foreword

- from Cluster E Convener,
  Arun MENON

Cluster E coordinates the activities of the Technical Committees (TCs) dealing with "Masonry, Timber and Cultural Heritage". At the moment, it comprises eight TCs, working on earth-en-materials (274-TCE, BEC, MAE and PEM), repair mortars (277-LHS), masonry reinforcement (290-IMC), decay induced by salt crystallization in various substrates (271-ASC) and timber joints (TPT).

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.

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. 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 2021, when I took over the role previously filled by Dr Enrico Sassoni, (University of Bologna, Italy). Under Enrico's supervision, Cluster E has developed a new community of earthen-based materials researchers. The recent establishment of 3 new TCs on this topic emphasises the world-wide interest in alternative and sustainable construction materials.

Current TCs in Cluster E

Code	Title	Chair	Deputy Chair	TC opened in
BEC	Bio-stabilised earth-based construction: performance-approach for better resilience	Ana BRAS	Céline PERLOT	Spring 2022 **NEW!**
MAE	Mechanical performance and durability assessment of earthen elements and structures	Antonin FABBRI	Christopher BECKETT	Spring 2022 **NEW!**
PEM	Processing of earth-based materials	Emmanuel KEITA	Arnaud PERROT	Spring 2022 **NEW!**
TPT	Tests methods for a reliable characterization of resistance, stiffness and deformation properties of timber joints	Jorge BRANCO	Andreas RINGHOFER	Fall 2021 **NEW!**
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

BEC | Bio-stabilised earth-based construction: performance-approach for better resilience

Chair **Ana BRAS**
Deputy Chair **Céline PERLOT**
Activity started in 2022

Screen shot of the online kick-off meeting of TC BEC, that was held in June 2022. Image courtesy of C. Perlot.

Significance

- Earth-based construction materials can significantly contribute to reducing global greenhouse gas emissions. However, the main weakness of these earthen materials is their sensitivity to water. To overcome this, the materials could be reinforced through stabilisations methods.
- The most frequent hydraulic binders (lime or cement) are used as chemical stabilisers, but they have the disadvantage to increase the carbon footprint of the earthen materials.
- Alternative bio-sourced methods with low environmental impact are increasingly used.
- At present, there is no fully established classification of bio-additives and bio-stabilisation methods.

Relevance

- This TC will contribute with guidelines for the development of international/European standards on earth testing procedures and on testing procedures for the use of bio-additives and bio-stabilisation methods for the construction materials sector.
- The work of this TC will interest academics, researchers, Ph.D. students, testing laboratories, research centres dedicated for construction, industrialists, engineers, and general public.
- The significance of this work appears to be particularly relevant to developing countries, notably sub-Saharan Africa and India.

Goals

- To understand how bio-additives and bio-stabilisation methods can modify mineralogy, microstructure, textural properties and structural performance of earth-based materials and improve durability performance.
- To assess the contribution to climate change adaptation of new and existing earth-based buildings.
- To suggest a definition and classification for different types of bio-additives and bio-stabilisation.

Methodology

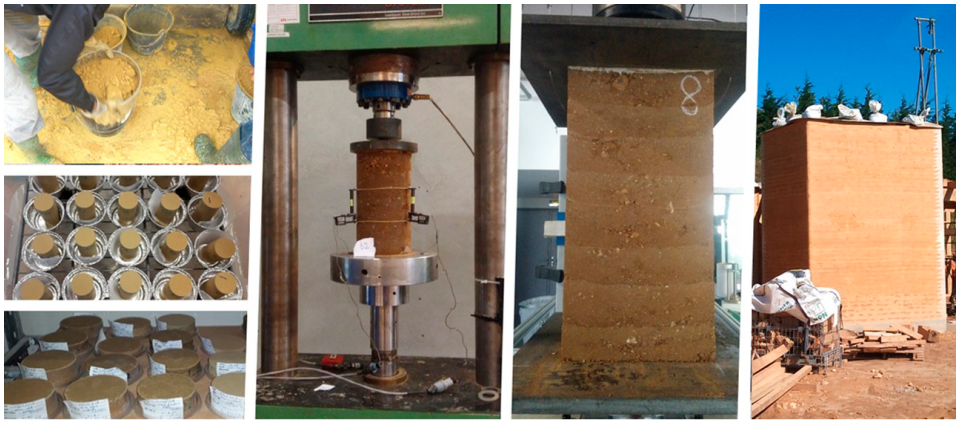
- The definition of a minimal number of tests – at the lab and in situ - will be done for an accurate assessment of physico-mechanical properties, hygro-thermal properties and durability of earthen materials and elements.
- Experimental protocols and design of the nature of each test may be modified as a function of the round robin tests that will be performed.
- This TC was designed together and in parallel with the following TCs: MAE - Mechanical performance and durability assessment of earthen elements and structures and PEM - Processing of earth-based materials. A transversal WP (WP0) is established to ensure throughout the duration of the 3 TCs the dissemination of scientific results (writing of journal articles, recommendations, practical guide, etc...), scientific events (doctoral school, participation in conferences, organisation of a conference).

Progress

The kick-off meeting of this TC was held in June 2022.

MAE | Mechanical performance and durability assessment of earthen elements and structures

Chair **Antonin FABBRI**
Deputy Chair **Christopher BECKETT**
Activity started in 2022



From the left to the middle: preparation and testing of earth-based material samples. On the right: full size (unscaled) rammed earth test wall. Image courtesy of A. Fabbri.

Significance

The relevance of building with earth in the 21st century has already been shown in showcase examples built in Switzerland (by Martin Rauch), France (by Nicolas Meunier) and China (by Lu Wenyu and Wang Shu - 2012 Pritzker Prize). However, the prospects of earthen and bio-based materials of entering mainstream construction, and *a fortiori* as the main structural materials, are limited notably due to the lack of knowledge on the assessment of their performance and durability.

A good understanding of the behaviour of crude earth is also crucial to develop proper methodologies for the rehabilitation and maintenance of buildings constructed more than 50 years ago.

Relevance

- This TC will mainly comprise academics and engineers.
- Strong interactions with architects and masons will be fostered by holding dedicated workshops. This will disseminate the TC's work to industrial bodies.

Goals

- This TC will produce dedicated testing procedures for unstabilised earth as a building construction material (crude earth).
- Its main goal is to advance scientific knowledge related to the performance assessment of earth as a building material and to encourage the transfer and application of these advances to practitioners through the edition of guidance and the organisation of dedicated workshops.
- In close collaboration with the two other TCs on earthen construction (TCs BEC and PEM), international conference on earthen constructions will be organised each two years during the lifetime of this TC.

Methodology

- The proposed technical committee would be a direct continuation of the previous committee on earthen construction, TC 274-TCE.
- Two scales of tests will be investigated: lab tests and on-site tests. A critical objective, for both scales, will be to define the type and minimal number of tests required in order to provide an accurate assessment of mechanical performance and durability of earthen materials and elements.
- Development of new experimental protocols and/or the adaptation of existing ones may be necessary.
- This TC is mainly based on experimental research and round-robin testing, which is quite time consuming. Thus, an estimation of 5 years should be quite realistic.

Progress

RILEM TC MAE been approved by RILEM TAC in Spring 2022. The kick-off meeting of this TC was held on 20th June, 2022.

PEM | Processing of earth-based materials

Chair **Emmanuel KEITA**
Deputy Chair **Arnaud PERROT**
Activity started in 2022

Significance

- The building sector contributes by a significant share to the entropic carbon emissions. In this context, earth appears as a promising solution for low carbon emission, recycling, and reuse in the construction field.
- In recent years, various rheometric and characterisation tests have been developed for earth-based building materials. However, some large scope aspects are often lacking.
- New formulations with additives offer ways to reduce the water content and suppress cracks while improving mechanical behaviour. There is a need to understand the underlying physics behind the additives effect in order to have mix-design strategies not only based on trials and errors or empirical methods.
- This TC will deal with the behaviour of earth-based material in its fresh state and during hardening.

Relevance

- The direct benefit of this TC is to extend the already fast-growing community on earth-based building materials in particular by attracting rheology experts.
- The targeted users are researchers, engineers and practitioners; Ph.D. students are welcome to be directly involved in the TC.

Goals

- This TC will deal with the behaviour of earth-based material in its fresh state and during hardening.
- The main goals of this TC are:
  - to describe the rheological behaviour of earth materials.
  - to define the rheometric characterization tools suitable for earth materials
  - to describe the curing and early-age behaviour.
  - to describe new processing methods

3D printing of earth-based materials. Image courtesy of A. Perrot.

Methodology

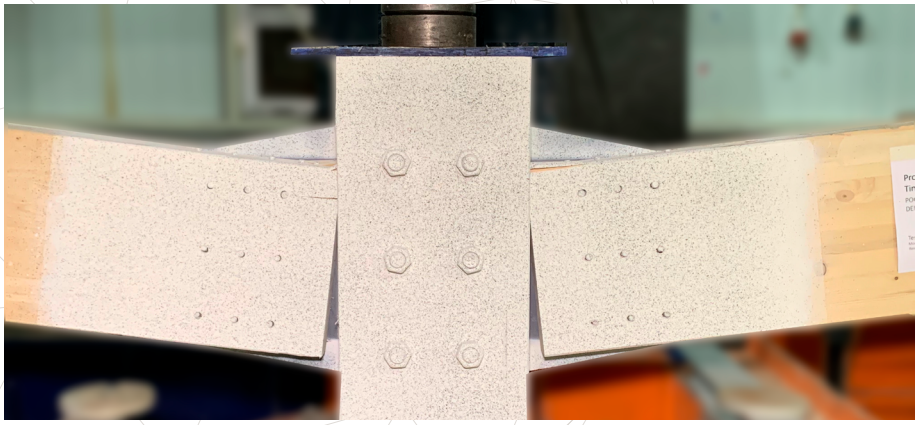
- The main work of this TC will be a bibliographic review on the developments made since the 2000s on fresh state and early age for earth-based materials. The work may include round-robin tests in a second phase or a following TC. The TC will also provide guidelines for future research.
- Work packages are as follows: 0) *Common dissemination & communication activities between this and TCs* MAE *and* BEC *to increase impact of activities developed at RILEM*; 1) Rheology of earth-based system; 2) Rheological characterization of earth materials; 3) Curing and early-age behaviour; 4) New processing methods.

Progress

The kick-off meeting of this TC was held in June 2022 with 40 participants. Members of the TC should select their Work Packages of interest. An in-person meeting will be organized in Lyon, France, in October 2022 by Antonin Fabbri, gathering the 3 TCs (MAE, BEC and PEM) on earthen construction.

TPT | Tests methods for a reliable characterization of resistance, stiffness and deformation properties of timber joints

Chair **Jorge BRANCO**
Deputy Chair **Andreas RINGHOFER**
Activity started in 2021



Laboratory testing of a timber joint.
Image courtesy of J. Branco.

Significance

- Existing test standards and protocols on timber joints are limited to the very simplistic nature of traditional connections.
- Although experimental campaigns provide important information on the mechanical behaviour of modern connections, the non-standardization of the test procedures often precludes the comparison between the obtained results.
- In order to allow for a better future evaluation and reusability of experimental data, existing testing protocols for timber joints should be discussed and reviewed.
- Reliable and well-established assessment methods are required, to support the safe and economic design of timber joints.

Relevance

- The committee is expected to run for 5 years with members recruited mainly from academia, industry and engineering practice. The participation in the TC of PhD students will be favoured, as well as academics, testing laboratories, industry, practitioners and standardization committees
- The outcomes of this TC contribute primarily to academia and testing laboratories. The published reports will serve as recommendation for the definition of tests methods for a reliable characterization of resistance and stiffness properties of timber joints.

Goals

- The main objective of the proposed TC is to develop standardized and reliable procedures for characterizing the resistance, stiffness and deformation properties of timber joints that are appropriate for design provisions and guidelines.
- This TC will evaluate and propose new testing methods for timber joints with STSs and dowel-type connections, to promote a more effective use of timber, which can be a real game-changer in construction efficiency, low environmental impact, and aesthetics.

Methodology

- Three types of fasteners and loading will be addressed: i) axially loaded self-tapping screws (STS) under axial and lateral loads; ii) laterally loaded dowel type fasteners, under both quasi-static and cyclic loading; and, glued-in rods (GiR) under axial and lateral loads.

Progress

The kick-off meeting of this TC was held on 26th April 2022, via Zoom. The TC is composed by 15 members – both from academia and industry - from all over the world; besides various European countries, Canada, India, Australia and Brazil are represented.
Two in-person meetings have been booked, namely, in Bad Aibling, Germany, within the INTER meeting and in Prague, Czech Republic, as part of the next SHATiS conference. In accordance with the workplan, the TC is now addressing the state-of-the-art report and for that, a workshop has been planned within the next World Conference on Timber Engineering to be help in Oslo, in June 2023.

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

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

Significance

Salt crystallization is a major cause of damage in porous building materials. Existing (standard) crystallization tests are generally not realistically reproducing the transport and crystallisation process, resulting in unrealistic damage types. The TC 271-ASC has been set up to develop an improved salt crystallization test procedure.

Progress

- TC outcomes presented at the 75th RILEM Annual Week in September 2022. The recording of the presentation is available on the RILEM YouTube channel.
- D'Altri A.M., et al., Towards a more effective and reliable salt crystallisation test for porous building materials: Predictive modelling of sodium chloride salt distribution, *Construction and Building Materials*, Volume 304, 18 October 2021.
- Nunes C., et al., Experimental research on salt contamination procedures and methods for assessment of the salt distribution, *Construction and Building Materials*, Volume 298, 6 September 2021.

Online TC 271-ASC meeting on Sept. 2021. Image courtesy of I. Rorig-Dalgaard.

- From the Proceedings of SWBSS 2021, Lubelli et al (Eds), Delft, The Netherlands, 22-24 Sept. 2021:
  - D. Gulotta, S. Godts, T. De Kock et al., Comparative estimation of the Pore Filling of Single Salts in Natural Stone, p.79-88
  - L. Kyriakou, A.M. Aguilar Sanchez , C. Nunes et al., Assessment of salt distribution in Maastricht and Migné limestones with the use of micro-destructive techniques, p. 153-162
  - B. Lubelli and TC 271-ASC, A new accelerated laboratory test for the assessment of the durability of materials with respect to salt crystallization, p. 55-68
  - C. Nunes, S. Godts , A.M. Aguilar Sanchez et al., Salt contamination procedures for the development of salt crystallization tests for porous building materials, p. 69-78
- This TC will close soon.

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

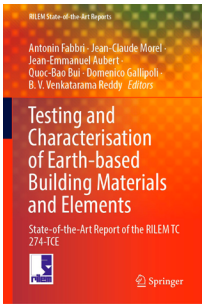
Chair **Jean-Claude MOREL**
Deputy Chair **Antonin FABBRI**
Activity started in 2016

Significance

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

Progress

- Testing and Characterisation of Earth-based Building Materials and Elements - State-of-the-Art Report of the RILEM Technical Committee 274-TCE; Edited by Antonin Fabbri, Jean-Claude Morel, Jean-Emmanuel Aubert, Quoc-Bao Bui, Domenico Gallipoli, B.V. Venkatarama Reddy; Vol. 35, Springer.
- TC outcomes presented at the 75th RILEM Annual Week in September 2022. The recording of the presentation is available on the RILEM YouTube channel.
- Fabbri, A., et al. An Overview of the Remaining Challenges of the RILEM TC 274-TCE, Testing and Characterisation of Earth-Based Building Materials and Elements. *RILEM Tech Lett* 2022, 6, 150-157.
- This TC's work is now finished. The work will continue through the 3 newly established TCs: MAE, BEC and PEM.



State-of-the-Art Report of the RILEM Technical Committee 274-TCE. Image courtesy of Springer.

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

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

Significance

The current trend in repairing Historic Structures (HS) is the use of Lime-Based Materials L-b-M. However, test procedures for repair mortars/grouts follow standards established for cement-based mortars/grouts. It is important to adapt/modify standard procedures for testing basic properties of L-b-M.

Progress

- International RILEM Workshop Lime based materials for repairing historic structures; Thessaloniki, 3-4 February 2022.
- 6th Historic Mortars Conference (HMC 2022) will take place in Ljubljana 21-23 September 2022.
- Three collective papers have been submitted to MAAS for publication. The stage of approval from all TC members and membership checking have been finished:

International RILEM Workshop Lime based materials for repairing historic structures. Image courtesy of TC 277-LHS.

- Groot, C. et al. (2022) Lime-based mortars for restoration. A review of long term durability aspects and experience from practice.
- Veiga, R. et al. (2022) Properties of lime-based renders and plasters - Discussion of current test methods.
- Maravelaki, N. et al. (2022) Additives and Admixtures for modern lime based mortars.

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

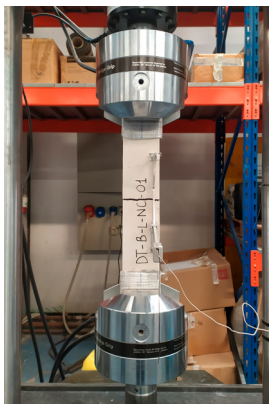
Chair **Maria Antonietta AIELLO**
Deputy Chair **Catherine PAPANICOLAOU**
Activity started in 2016

Significance

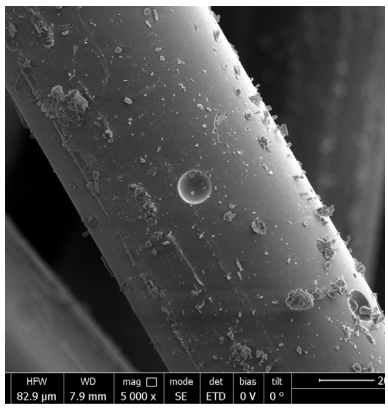
Fiber Reinforced Polymer (FRP) materials do not always provide an efficient strengthening solution for masonry structures. Inorganic Matrix Composites (IMC) have been studied as an affordable solution, especially for historical masonry. The study of the long-term behaviour, currently missing, is necessary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

Progress

- Durability test campaign on TRM / FRCM / CRM (alkaline environment exposure):
  Experimental work has started (8 labs and 20 products) and it will progress but with lags depending on receipt of materials.



Tensile test on glass FRCM. Image courtesy of University of Roma Tre.



SEM Microscopy on glass fibers after moderate alkaline exposure. Image courtesy of University of Salento.

- State of-the-Art on "Strengthening of masonry structures with IMC: Durability Aspects and Structural implications": ~85% completion rate.
- Delays in experimental work due to the pandemic.

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 need for increased sustainability and resilience for road infrastructure, 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 and to adapt to climate change. Currently, Cluster F, chaired by Eshan V. Dave, University of New Hampshire, USA, engages approximately 150 experts from 25 countries, and is composed of 8 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.

More than 35 individual TC conferences, symposia, seminars and workshop, took place since the late 1960s, including conferences 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), Braunschweig (2018), and Lyon (2020). Moreover, some well attended and broadcasted annual joint cluster F meetings, e. g. in Nottingham (2017), Braunschweig (2018), Waterloo (2019) and over Zoom in (2020 and 2021). Cluster has recently established a regular joint conference, for promoting latest developments in this research field to a wider audience.

Current TCs in Cluster F

Code	Title	Chair	Deputy Chair	TC opened in
PAR	Performance-based Asphalt Recycling	Gabriele TEBALDI	Eshan V. DAVE	Spring 2022 **NEW!**
PPB	Physicochemical effects of polymers in bitumen	Hinrich GROTHE	Ayse KOYUN	Fall 2021 **NEW!**
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
295-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

PAR | Performance-based Asphalt Recycling

Chair **Gabriele TEBALDI**
Deputy Chair **Eshan V. DAVE**
Activity started in 2022

Crumb rubber, glass and construction & demolition waste are amongst the types of waste materials that are used in road pavements. Image courtesy of RILEM Newsletter.

Photo of the kick-off meeting of TC PAR in June 2022. Image courtesy of E. Dave.

Significance

Although the significant efforts underway to develop and implement balanced mix design tools for bituminous mixtures that adopt performance related laboratory tests to support proportioning of mixture, there is a lack of consensus on the selection of laboratory tests as well as their thresholds.
The outcomes of this TC will have balance between fundamental developments and knowledge disseminations to aid in improved mixture design methods and use of life-cycle analysis tools.

Relevance

- The activities of the proposed TC are well aligned with the current needs of European Asphalt Paving Association (EAPA) and the United States' National Asphalt Paving Association. Technical directors from both these associations will be active member of the proposed TC.
- Academics, road authorities and standardization committees, Testing laboratories and test equipment producers, Material producers and construction equipment manufacturers, Professionals and practitioners, and Researchers will benefit from the outcomes of this TC.

Goals

- This TC aims to develop and disseminate new standardized methods, conduct round robin and interlaboratory studies, and advance the state of art as well as practice on the topic of material characterization and infrastructure construction.
- Outcomes of this TC:

- Development of standardized procedures for performance assessment of recycled asphalt mixtures

- Development of material selection and mix design procedures in the context of recycled asphalt mixtures using performance-based specifications.

- Development of LCA tools to support PCR and EPD development.

- To provide methods and manuals to state and national transportation agencies that can help develop sustainable pavement solutions by combining material recycling with life cycle assessment.

Methodology

- The proposed RILEM technical committee will follow the previous TC 264-RAP to continue scholarly research and knowledge dissemination on the asphalt material recycling.
- TC activities will enhance of the fundamental understanding on the interactions between recycled asphalt (RA) materials and new virgin materials in asphalt paving mixtures in context of the impacts of RA use on performance of pavements.
- The proposed TC will undertake four interlaboratory studies on topics of performance based cold recycled asphalt mixture design procedures, selection and dosage recommendations for asphalt recycling agents (binder additives), quantification of the degree of binder activation and blending between RA binder and new virgin asphalt binder added to mixes, and finally on optimizing the warm mix asphalt designs with RA on the basis of long-term performance.
- Further, TC will also undertake a comparative analysis of different product category rules (PCR) and environmental product declaration (EPD) development procedures on the basis of life cycle assessment.

Progress

This TC was approved in Spring 2022 and had its kick-off meeting in June of the same year, with 27 in person attendees and approximately 50 online attendees.

PPB | Physicochemical effects of polymers in bitumen

Chair **Hinrich GROTHE**
Deputy Chair **Ayse KOYUN**
Activity started in 2021

Styrene Butadiene Styrene (SBS) resin. Image courtesy of LG Chem.

Significance

Polymers are added to bitumen with the general intention to increase the durability of asphalt layers by enhancing their resilience to mechanical and environmental effects.
The ageing of bitumen is commonly quantified using several approaches based on the temporal deterioration of its mechanical properties.
The spectroscopic and microscopic techniques (like infrared and fluorescence spectroscopy and microscopy, atomic force microscopy, and scanning electron microscopy) are increasingly getting into the focus of scientists because they are able to characterise the chemical and microstructural changes of bitumen from a more intrinsic aspect.
The goal of this TG is to identify and compare available methods for fingerprinting and quantification of certain additives and judge their benefits.

Relevance

The new TC will continue to attempt to incorporate more members from outside Europe to broaden the global impact and dissemination.
Targeted users of the outcomes of this TC will be: academics, material producers, road authorities, and standardisation, testing laboratories and test equipment, professionals and practitioners.
Enabling the characterisation of physicochemical binder properties under the influence of these complex processes could potentially lead to improved and/or new bituminous binders with enhanced durability characteristics, thus contributing to the social and economic challenge of sustainability.

Goals

Gathering and reviewing existing knowledge on microscopy and spectroscopy as well as the EHS aspects.
A review article is planned to comprehensively summarise the current knowledge for the scientific community (literature review).
Stability and aging tests of PmB will be conducted with the aim to identify mixtures which are particularly suitable for recycling (interlaboratory testing).
Identifying potential methods for the chemo-mechanical fingerprinting of PmB (experimental).
Assessment of the environmental effects of PmB, rheology, mechanical testing, DSR, Recycling of bitumen with regards to polymer content and type.

Methodology

The research shall be focussed on the following polymers: SBS, XSB, EVA.
In a first step this proposed RILEM technical committee will collect and review the knowledge on linking polymer modification and physicochemical and rheological characterisation methods developed by past RILEM TCs and the community to have a solid basis for its own work. This experimental work of the committee will include bituminous binders, different types of polymers and other additives.
Based on the results obtained, recommendations for the standardised use of these methods and chemo-mechanical links will be provided.

Progress

This TC was approved in Fall 2021 and had its kick-off meeting on 8th March, 2022 via Zoom.

272-PIM | Phase and interphase behaviour of bituminous Materials

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

Significance

Innovation in the field of pavement construction is always facing difficulties in defining the "relevant" properties not only for the innovative products, but also in comparison with conventional solutions. To facilitate sustainable implementations of new materials, additives and processes, it is necessary to:

- 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.

Progress

- From the Proceedings of the RILEM International Symposium on Bituminous Materials (ISBM Lyon 2020), edited by Hervé Di Benedetto, Hassan Baaj, Emmanuel Chailleux, Gabriele Tebaldi, Cédric Sauzéat and Salvatore Mangiafico (RILEM, volume 27), 2022:

- Interlaboratory Test to Characterize the Cyclic Behavior of Bituminous Interlayers: An Overview of Testing Equipment and Protocols, Francesco Canestrari, Thomas Attia, Hervé Di Benedetto, Andrea Graziani, Piotr Jaskula, Youngsoo Richard Kim et al., Pages 29-36

- Complex Bituminous Binders, Are Current Test Methods Suitable for?, Laurent Porot, Emmanuel Chailleux, Panos Apostolidis, Jiqing Zhu, Alexandros Margaritis, Lucia Tsantilis, Pages 37-43

Advanced Shear Tester (AST) used by the participating laboratories of TC 272-PIM. Image courtesy of TC 272-PIM.

- TC outcomes presented at the 75th RILEM Annual Week in September 2021. The recording of the presentation is available on the RILEM YouTube channel.
- Apostolidis, P., Elwardany, M., Porot, L. *et al.* Glass transitions in bituminous binders. *Mater Struct* **54**, 132 (2021).
- Mirwald, J., Nura, D. & Hofko, B. Recommendations for handling bitumen prior to FTIR spectroscopy. *Mater Struct* **55**, 26 (2022).

278-CHA | Crack-healing of asphalt pavement materials

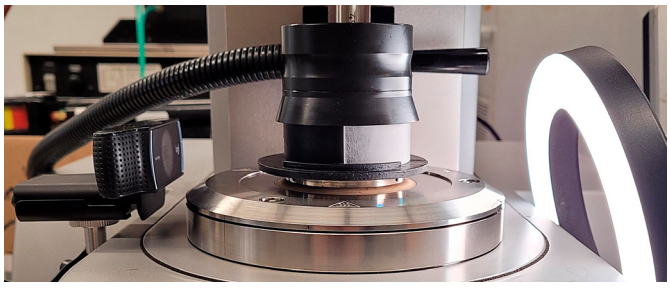
Chair **Hassan BAAJ**
Deputy Chair **Orazio BAGLIERI**
Activity started in 2016

Significance

Cracking is one of the most prevalent deterioration modes of 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.

Progress

- From the Proceedings of the RILEM International Symposium on Bituminous Materials (ISBM Lyon 2020), edited by H. Di Benedetto, H. Baaj, E. Chailleux, G. Tebaldi, C. Sauzéat and S. Mangiafico (RILEM, volume 27), 2022:



Dynamic Shear Rheometer testing set-up. Image courtesy of O. Baglieri.

- Terms and Definitions on Crack-Healing and Restoration of Mechanical Properties in Bituminous Materials, G. Leegwater, A. Taboković, O. Baglieri, F. Hammoum, H. Baaj, pages 47-53

- Testing Methods to Assess Healing Potential of Bituminous Binders, Orazio Baglieri, Hassan Baaj, Francesco Canestrari, Chao Wang, Ferhat Hammoum, Lucia Tsantilis et al., pages 55-62.

- State of the Art Report – in progress, to be completed by the end of August 2022.

279-WMR | Testing of waste and marginal materials for roads

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

Significance

Use of various waste and marginal materials in roads can be a technically viable option without compromising performance and with significant savings in CO_2 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.

Progress

- RILEM Technical Committee 279-WMR Workshop "Valorisation of Waste and Secondary Materials for Roads", December 14-16, 2020 - Lyon, France.
- Tuša M. et al., RILEM TC 279 WMR Round Robin study on waste polyethylene modified bituminous binders: advantages and challenges, R*oad Materials and Pavement Design*, Dec 2021.
- Pasetto, M. *et al.* (2022). An Interlaboratory Test Program on the Extensive Use of Waste Aggregates in Asphalt Mixtures: Preliminary Steps. In Di Benedetto, H., Baaj, H., Chailleux, E., Tebaldi, G., Sauzéat, C., Mangiafico, S. (eds) Proceedings of the RILEM International Symposium on Bituminous Materials. ISBM 2020. RILEM Bookseries, vol 27. Springer.
- Wang, D. et al. Rheological behaviors of waste polyethylene modified asphalt binder: statistical analysis of inter-laboratory testing results. Accepted for ISAP 2022, Costa Rica.
- Wang, D. et al. Rheological properties of asphalt bitumen modified with waste polyethylene: an interlaboratory research. Under review of Resources Conservation and Recycling.
- TC activities will be presented at the v following the invitation of Department DICEA of the University Federico II of Naples (Italy).

Plastic waste added to asphalt mixture. Image courtesy of Ecole de technologie supérieure, U. du Quebec.

280-CBE | Multiphase characterisation of cold bitumen emulsion materials

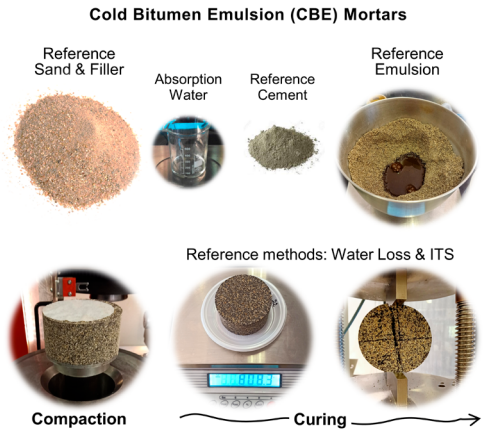
Chair **Andrea GRAZIANI**
Deputy Chair **Alan CARTER**
Activity started in 2017

Significance

Cold bitumen emulsion technologies are proven sustainable solutions for pavement construction and rehabilitation. A lack in fundamental knowledge on the long-term behaviour of structural and non-structural cold bitumen emulsion materials limits their usage. TC 280-CBE will develop a consistent experimental framework for characterizing the mix design and performance properties of cold microsurfacings.

Progress

- Meknaci L., et al., Influence of bitumen emulsion on the curing behaviour of standardised cold bitumen emulsion mortars, Road Materials and Pavement Design, 28 Dec 2021.



Schematics of preparation and testing of reference cold bitumen emulsion mortars. Image courtesy of A. Graziani.

- TG2: About 90% of the inter-laboratory test completed.
- Testing is almost completed; extension of TC life (2022->2023) granted in Spring 2022.

295-FBB | Fingerprinting bituminous binders using physico-chemical analysis

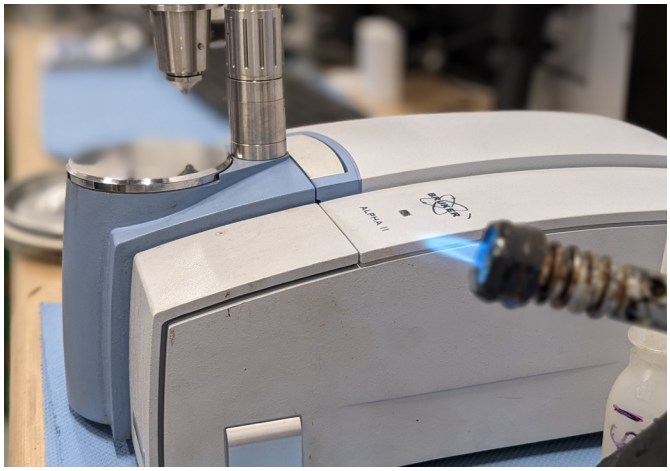
Chair **Bernhard HOFKO**
Deputy Chair **Aikaterini VARVERI**
Activity started in 2020

Significance

Bitumen is an organic material and as such it is prone to aging. Oxidative aging causes an increase of brittleness and stiffness, resulting in higher risk for cracking. We need to track bitumen oxidation to ensure long-lasting and sustainable road infrastructure. Enhanced long-term performance 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 missing.

Progress

- Round robin TG1 – Phase 1: First results (measurement of 1 unaged binder and reference material) is almost complete. Data evaluation will be discussed in the next TG1 meeting.
- Round robin TG1 – Phase 2: Work program for round robin tests is ongoing. Labs have started measuring the rest of the materials; first results received.



FTIR device to detect chemical composition of bituminous samples. Image courtesy of J. Mirwald.

- TG2: Two focus groups working on systematic reviews :
  - Promising Elemental Analysis Techniques as Diagnostic Tools to Detect Additive Presence in Bituminous Binders.
  - Dynamic Scanning Calorimetry for Fingerprinting of Bituminous Binders from Different Sources: A Systematic Review.

FEE | Fume emission evaluation for asphalt materials

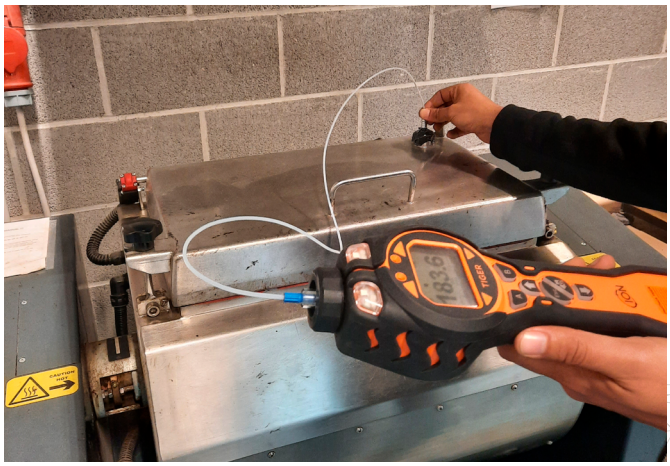
Chair **Johan BLOM**
Deputy Chair **Laurent POROT**
Activity started in 2021

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.

Progress

- Successful kick-off meeting on Oct 27th 2021 with 25 people from Europe, US, Asia.
- Each TG had a “kick-off” meeting in May 2022.



Ion Tiger VOC gas detector using photoionisation (pid).
Image courtesy of J. Blom.

- TG-1 and TG-2 plan to have STAR contributions by 2023.
- TG-3 will administer a survey through industrial associations in 2022.

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
262-SCI	Characteristics of the steel/concrete interface and their effect on initiation of chloride-induced reinforcement corrosion	Ueli ANGST	Mette GEIKER	2014	Fall 2021
270-CIM	Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice	Eddie A. B. KOENDERS	Kei-Ichi IMAMOTO	2016	Fall 2021
264-RAP	Asphalt Pavement Recycling	Gabriele TEBALDI	Eshan V. DAVE	2015	Fall 2021
267-TRM	Tests for reactivity of supplementary cementitious materials	Karen SCRIVENER	Ruben SNELLINGS	2015	Spring 2022

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.

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

- Wong, H.S., Angst, U.M., Geiker, M.R. *et al.* Methods for characterising the steel–concrete interface to enhance understanding of reinforcement corrosion: a critical review by RILEM TC 262-SCI. *Mater Struct* **55**, 124 (2022).

270-CIM: Benchmarking Chloride Ingress Models on Real-life Case Studies: Theory and Practice

- Benchmarking Chloride Ingress Models on Real-life Case Studies - Marine submerged and Road Sprayed concrete structures – *State-of-the-Art Report of the RILEM Technical Committee 270-CIM*, edited by Eddie Koenders, Kei-ichi Imamoto and Anthony Soive.
- Preparation of journal paper on the benchmark and real-life case studies to be submitted to *Materials and Structures*.
- TC outcomes presented at the 75th RILEM Annual Week & International Conference on Advances in Sustainable Construction *Materials and Structures*. Video of the presentation available on the RILEM YouTube channel.

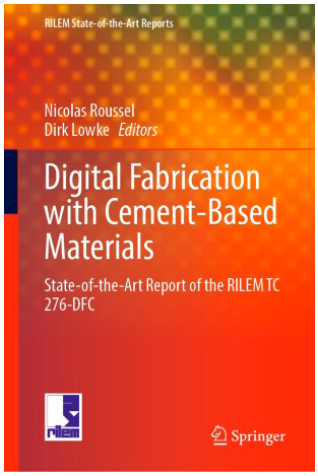
264-RAP: Asphalt Pavement Recycling

- Hugener, M., Wang, D., Cannone Falchetto, A. *et al.* Recommendation of RILEM TC 264 RAP on the evaluation of asphalt recycling agents for hot mix asphalt. *Mater Struct* **55**, 31 (2022).

- A second recommendation is currently in preparation.
- From the Proceedings of the RILEM International Symposium on Bituminous Materials (ISBM Lyon 2020), edited by Hervé Di Benedetto, Hassan Baaj, Emmanuel Chailleux, Gabriele Tebaldi, Cédric Sauzéat and Salvatore Mangiafico (RILEM, volume 27), 2022:
  - Effect of Aging on the Rheological Properties of Blends of Virgin and Rejuvenated RA Binders, Di Wang, Augusto Cannone Falchetto, Martin Hugener, Laurent Porot, Atsushi Kawakami, Bernhard Hofko et al., Pages 3-10.
  - Experimental Investigation on Water Loss and Stiffness of CBTM Using Different RA Sources, Andrea Grilli, Simone Raschia, Daniel Perraton, Alan Carter, Amir Rahmanbeiki, Patricia Kara De Maeijer et al., Pages 11-17.
  - International Evaluation of the Performance of Warm Mix Asphalts with High Reclaimed Asphalt Content, Paul Marsac, Edoardo Bocci, Fabrizio Cardone, Augusto Cannone Falchetto, Xavier Carbonneau, Martins Zaumanis et al., Pages 19-25.
- STAR chapters from all Task Groups are completed, chair and deputy chair are editing them.

267-TRM: Tests for reactivity of supplementary cementitious materials

- Closing meeting held in October 2021.
- Three papers in the topical collection "TC-267 TRM: Development and validation of tests for measuring the reactivity of supplementary cementitious materials" published by *Materials and Structures* in 2022, concluding the activities of the TC:
  - Parashar, A., Vollpracht, A., Haufe, J. *et al.* Report of RILEM TC 267—TRM: Improvement and robustness study of lime mortar strength test for assessing reactivity of SCMs. *Mater Struct* **55**, 96 (2022).
  - Avet, F., Li, X., Ben Haha, M. *et al.* Report of RILEM TC 267-TRM phase 2: optimization and testing of the robustness of the R3 reactivity tests for supplementary cementitious materials. *Mater Struct* **55**, 92 (2022).
  - Londono-Zuluaga, D., Gholizadeh-Vayghan, A., Winnefeld, F. *et al.* Report of RILEM TC 267-TRM phase 3: validation of the R3 reactivity test across a wide range of materials. *Mater Struct* **55**, 142 (2022).
- Presentation of results at ASTM event "Symposium on Reactivity Tests for Cement-based Materials - From Lab Testing to Standards and Specifications", June 2022.



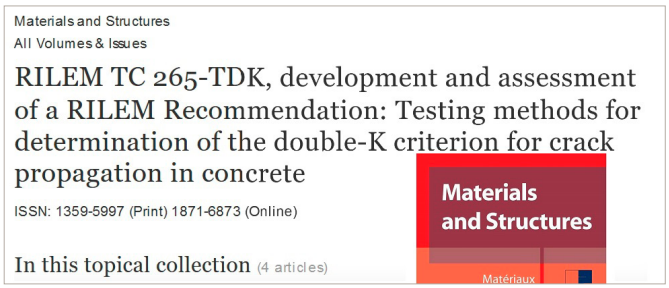
Here also come the latest publications and videos of some past TCs, released after their closure dates.

276-DFC: Digital fabrication with cement-based materials:

Chair: Nicolas ROUSSEL, Deputy Chair: Dirk LOWKE

- STAR 276-DFC: Digital Fabrication with Cement-Based Materials, State-of-the-Art Report of the RILEM TC 276-DFC, Edited by Nicolas Roussel, Dirk Lowke, Volume 36 published by Springer.
- TC outcomes presented at the 75th RILEM Annual Week & International Conference on Advances in Sustainable Construction Materials and Structures. Video of the presentation available on the RILEM YouTube channel.

265-TDK: Testing methods for determination of double-K criterion for crack propagation in concrete



Chair: Shilang XU, Deputy Chair: Yao WU

- Topical Collection in *Materials and Structures* gathering the 4 recommendations produced by this TC:
  - RILEM Standard: testing methods for determination of the double-K criterion for crack propagation in concrete using wedge-splitting tests and three-point bending beam tests, recommendation of RILEM TC265-TDK
  - Influential factors for double-K fracture parameters analyzed by the round robin tests of RILEM TC265-TDK
  - The theoretical basis of testing methods to determine double-K criterion for crack propagation in concrete: technical report of the RILEM TC265-TDK
  - Results of round-robin testing for determining the double-K fracture parameters for crack propagation in concrete: technical report of the RILEM TC265-TDK

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

Chair: Børge Johannes WIGUM, Deputy Chair: Jan LINDGÅRD

- Topical Collection in *Materials and Structures* gathering the 7 papers produced by this TC:
  - RILEM AAR-0 outline guide to the use of RILEM methods in the assessment of the alkali-reactivity potential of concrete
  - RILEM AAR-8: determination of potential releasable alkalis by aggregates in concrete
  - RILEM AAR-10: determination of binder combinations for non-reactive mix design using concrete prisms – 38 °C test method
  - RILEM AAR-11: determination of binder combinations for non-reactive mix design or the resistance to alkali-silica reaction of concrete mixes using concrete prisms – 60 °C test method
  - RILEM AAR-12: determination of binder combinations for non-reactive mix design or the resistance to alkali-silica reaction of concrete mixes using concrete prisms – 60 °C test method with alkali supply
  - RILEM AAR-13: application of alkali-wrapping for concrete prism testing to assess the expansion potential of alkali-silica reaction
  - Wigum, B.J., Lindgård, J. Preface: RILEM technical committee 258-AAA–Development of a performance-based testing concept. *Mater Struct* **55**, 16 (2022).

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

Chair: Pedro SERNA, Deputy Chair: Sergio CAVALARO

- Fibre Reinforced Concrete: Improvements and Innovations II - X RILEM-fib International Symposium on Fibre Reinforced Concrete (BEFIB) 2021; Eds. P. Serna, A. Llano-Torre, J.R. Martí Vargas, J. Navarro-Gregori; Vol. 36.

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Concluding remarks

By the RILEM Presidents

Another year, another RILEM Technical Report! The fourth edition, to be precise. This 2021-2022 issue has something different: the authors of the concluding remarks or, in other words, the composition of the RILEM Presidency. In September 2021, we thanked Johan Vyncke for having served the RILEM Presidency over 9 long years in his role of Vice-President (2013-2015), President (2016-2018) and Past-President (2019-2021), and we welcomed Nele De Belie as new RILEM Vice-President.

RILEM Presidency 2022-2024

Vice-President	President	Past-President
		
Nele De Belie, Belgium	*Nicolas Roussel, France*	*Ravindra Gettu, India*

Johan Vyncke, Belgium

Vice-President	President	Past-President

RILEM Presidency 2019-2021

The last 12 months have been full of events and initiatives to celebrate the 75th RILEM anniversary:

- The RILEM 75th Anniversary Book and its Appendix, released in September 2021, are the result of the tremendous effort of Mark Alexander, who edited these documents. Mark collected feedback, funny anecdotes, historical data and much more to release this anthology of the RILEM history.
- Another initiative related to the anniversary was the release of the Topical Collection "75 years of RILEM: Materials and Structures", a collection of 25 papers, each of them presented with an introduction written by an expert in the field. The collection also features a preface from one of us, RILEM President Nicolas Roussel, explaining the selection criteria for these papers and their relevance in the scientific community.

- At the last Spring Convention, held in hybrid mode in Paris, France, a full-day webinar was organised on 17th March. Beside the outstanding presentations from internationally recognised RILEM members on most of the current RILEM topics, the webinar offered a panel discussion that focused on the strategic way forward of the organization. The discussion is available online.

The future of RILEM is green:

- RILEM supports GLOBE, that is getting more and more active and established since its launch in 2020. The last workshop in Lausanne, Switzerland, addressed high level decision makers and change drivers towards sustainability in the built environment with the overall objective to collect opinions, input and discussion topics for a GLOBE Consensus Policy Note. The Note is aimed to be published before the UN Climate Change Conference 2022 (UNFCCC COP 27) in November 2022.
- Reduction of carbon footprint and circular economy are often if not always mentioned amongst the aims of all the existing RILEM TCs. The advancement of "*scientific knowledge related to construction materials, systems and structures*" (RILEM's mission) cannot move forward without embracing the new climate issues that our planet is facing these days.

We have learned that HYBRID is the key-word for the future. We cannot survive purely online, but we cannot afford to travel as we used to do before COVID. Many Technical Committees hold their meetings in hybrid mode nowadays. The meeting of the RILEM General Council, the decision-making body of RILEM called upon to vote on all important decisions, composed of the Members of RILEM, is held in hybrid mode.

Technology is evolving fast and RILEM keeps up with its pace! We have welcomed the first TC on Artificial Intelligence this year (DCS - Data-driven concrete science); the community of 3D printing of concrete is rapidly growing with three new TCs established after the closure of the "original" one 276-DFC - Digital fabrication with cement-based materials.

This RILEM Technical Report contains a wealth of information on the activities of RILEM and the progress of all active RILEM Technical Committees. We hope you have enjoyed reading it and that it may encourage you to actively participate in our TCs. We look forward to meeting you at one of our future events!

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