EUROPEAN MECHANICS SOCIETY

Colloquium n. 637 – A multidisciplinary discussion on binder cohesion

Dates and location

15 May — 17 May 2024, Vienna, Austria

Chairperson

Agathe Robisson

Co-chairperson

Katerina Ioannidou, Teresa Liberto

Conference fees

- Regular registration: **250.00 €**

What other funding was obtained?

We have received financial support from Anton Paar, CNRS France, Schleibinger and VÖZ (Austrian Cement Industry Association).

What were the participants offered?

The registration fees included:
- The book of abstracts.
- 2 daily coffee breaks and three lunches.
- Guided visit of Josephinum (Medical History Museum) and welcoming cocktail/snacks.
- Gala dinner Joseph II in the Schönbrunn Palace.

Applicants (members)

1. Roberta Alfani
2. Catherine Barentin
3. Maurizio Bellotto
4. Ana Bruncic
5. Barbara Bucher
6. Roberto Cerbino
7. Jean Colombani
8. Philippe Coussot
9. Maria Chiara Dalconi
10. Thibault Demoulin
11. Paulo De Souza Mendes
12. Sabina Dolenec
13. Romain Dupuis
14. Joanna Dziadkowiec
15. Daniel Ferry
16. Michael Haist
17. Žan Hauptman
18. Pascal Hebraud
19. Stefan Holler-Stangl
20. Robert Hula
21. Katerina Ioannidou
22. Andreas Jäger
23. Nikolaos Kalafatakis
24. Helena Keller
25. Florian Kleiner
26. Benjamin Kromoser
27. Christophe Labbez
28. Marie Le Merrer
29. Teresa Liberto
30. Markus Mahlbacher
31. Oliver Mazanec
32. Milot Muhaxheri

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39. Franck Radjai
40. Agathe Robisson
41. Christiane Rößler
42. Peter Schwesig
43. Thomas Sowoidnich
44. Sebastian Spaun
45. Bastian Strybny
46. Gernot Tritthart
47. Luca Valentini
48. Markus Valtiner
49. Henri Van Damme
50. Thomas Wattez
51. Vesna Zalar Serjun
52. Helga Zeitlhofer
53. Chi Zhang
54. Xinping Zhu

Scientific report

This report reflects the concepts presented and discussed during the colloquium. Some of them may reflect opinions rather than well-documented facts.

The colloquium started with Session 1 “Viewpoints on sustainability in construction and concepts of multifunctional cementitious materials I.”, chaired by R. Pellenq. It contained 3 introductory presentations from an academic expert, H. Van Damme, ESPCI Paris, titled “Civil engineering in the age of conflicting constraints”, from an industrial expert, S. Spaun, VÖZ -Austrian Cement Industry Association- titled “Roadmap for sustainable concrete in Austria”, and from an architect, T. M. Room, forschen planen bauen ZT, titled “Resources on the building site, the Genius Loci”.
The yearly worldwide consumption of concrete is estimated to 30 billion tons, equivalent to building a wall of 50 cm wide, 6 m height, going 3 times to the moon and back. Austria was an early user of slag, a practice that was not seen positively at the time but was leading the way. In Austria, carbon dioxide (CO_2) linked to cement production comes 2/3 from limestones and 1/3 from fuel. Austria is one of the 7 European countries to burn waste only (and nothing else) during cement manufacturing.
Separation of CO_2 in a cement plant is challenging for the industry because new chemical processing expertise is needed. Sending CO_2 to the north sea requires pipelines that still need to be built. Also, switching energy source in the Rohdorfer cement plant, for example, would triple the electricity demand of the town.
The proper use of excavation material on site still lacks, as well as standards that would promote the use of low-CO_2 customized concrete.
In terms of material development, aggregates such as basaltic rocks may store a large amount of carbon dioxide, the fine fraction of demolition waste could also be quickly carbonated. Strength of building materials could also rely more on friction than on cohesion. Better packed calcium silicate hydrates (C-S-H) is a nice concept, but it is unclear how this enables a lower use of cement or slag. The use of biochar (negative global warming potential -GWP-) remains controversial: it may partially offset the GWP of a concrete but may not be the best use of biochar. Optimizing material use should be done at a global level, not a local one. At short term, biochar is still considered by many end-users as a viable option to reduce the GWP of concretes.
If LC3 remains an alternative to CEM I and II in Europe remains an open question, due to limited local kaolinite resources. The increase use of wood brought concerns that the forest surface in Europe was decreasing.
Overall, the poor public image of cement and concrete may not be deserved, but it is generally accepted that its use should be

scrutinized, as its extraordinary properties are often an overshoot and may not be required in many cases.

The session continued with presentations by B. Bucher on building heritage and land usage, P. Coussot on fluid transfers in bio-based construction materials and V. Zalar on the influence of coal fly ash carbonation on its binding and geotechnical properties.

Session 2 “Mechanics of cementitious materials in their fresh and early-age states” was chaired by A. Robisson, and included presentations by C. Barentin on wetting of complex fluids, M. Le-Merrer on setting of mineral foams, P. De Souza Mendez on cement paste optimized for rheometric characterization, M. Palacios on new insights into the evolution of the rheological properties of superplasticized limestone calcined clay cements (LC3) and O. Mazanec on a new admixture generation to break the wall to more sustainable concrete.

Next, a round table “Present and future of the construction industry” was chaired by S. Spaun (VÖZ), and focused on the need of decarbonization in the cement industry, on roadmaps and massive investments, on new cementitious materials and low carbon formulations and technologies, on multifunctional concrete, and on navigating policies and regulations. Participants included R. Alfani (Ecocem), G. Tritthart (Holcim), O. Mazanec (Master Builders), T. Demoulin (Oxara) and A. Jäger (Wienerberger). The low cost of cement, due to the exceptional optimization of the industry in the last 50 years, remains an obstacle to the implementation of innovative products, in an industry where an increase of 1 cent pro kg of material is problematic. Cement and concrete cost far less than a bottle of water. Questions on the industrialization of rammed earth was discussed, but acceptance by the big players remains difficult, due to the cost of qualified workers and the lengthy construction processes. The relatively new constraint on GWP potential of construction material may support innovation, but the cost pressure on the industry would need to be higher. Regulations remain important (example of Turkey) and should not be compromised, but the development of property-based rather than recipe-based standards should be accelerated.

Session 3 “Physico-chemical characterization of cementitious materials” was chaired by T. Liberto. It included presentations by J. Colombani J. on local measurement of the reactivity of hydraulic binders, D. Ferry on intimate details of cementious materials from high-resolution 3D imaging, T. Sowoidnich on early C3S hydration studied by analytical ultracentrifugation, optical emission spectroscopy and isothermal conduction calorimetry, C. Rößler on SEM imaging and mesoscale modelling of cement hydration, M. Valtiner on probing chemical reactivity in confined spaces, J. Dziadkowiec on measurements of surface forces between reactive mineral surfaces and P. Hébraud on very early stage dynamics of cementitious pastes.

Session 4 “Mechanics of cohesion in cementitious materials” was chaired by K. Ioannidou. It included presentations from R. Pellenq on the understanding cement paste cohesion and degradation with the multi-scale modeling framework, R. Dupuis on unraveling the molecular basis of silica-based gels formation through simulations, X. Zhu on interfacial carbonation of portlandite, A. Bruncic on controlling the stability of cement suspension with siliceous additives, R. Cerbino on yielding under the microscope: a multi-scale perspective on brittle and ductile behaviors in oscillatory shear, C. Labbez on the dependence of calcined-clay-cement paste rheology on the surface charge and reactivity of calcined clays, B. Pichler on the universal precipitation characteristics of hydrates in white cement pastes, identified by means of proton NMR relaxometry.

Session 5 “Viewpoints on sustainability in construction and concepts of multifunctional cementitious materials II”, was chaired by M. Bellotto. It included presentations from M. Bellotto on cohesion: meaning and origins, M.C. Dalconi on nanoscale characterization of calcium silicate hydrates using synchrotron X-

ray total scattering, L. Valentini on sustainable resource utilization in lunar construction, P. Preinstorfer on functionally grading of cementitious materials in textile-reinforced concrete: possibilities, constraints and sustainability potential, B. Kromoser on possible levers to decrease the environmental impact of mineral building components and the quantification thereof, and M. Haist (given by B. Strybny) on the rheological challenges on the pathway to sustainable concrete.

Over the colloquium, 12 fire presentations and 3 poster sessions were organized.

Finally, after the colloquium, a visit of the TUW civil engineering labs was offered.

Number of participants from each country

Country	Participants
Austria	16
France	15
Germany	10
Slovenia	4
Italy	3
Albania	2
Switzerland	1
Brazil	1
Norway	1
Spain	1
Total	**54**