RYS 2025: Book of Abstracts

Covering Presentations on 20-21 October, 12-15.30h CEST (UTC+2, Paris time)

20-Oct

Room 1 - Earthen materials
DAY 1

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Recent advancements on the effect of bio-stabilisation on the mechanical and hygrothermal properties of earthen building materials**	Alessia Losini, Agostino Walter Bruno, Magda Posani, Samuel J. Armistead, Adewumi John Babafemi, Paulina Faria, Simon Guihéneuf, Ioannis Ioannou, Alejandro Jiménez Rios, Muralidhar Kamath, Derrick Mwebaza, Rafail Panagiotou, Alessandra Ranesi, Magdalini Theodoridou, Selina Vaculik, Snežana Vucetic, Guillaume Habert, Céline Perlot, Ana Margarida Armada Brás	alessialosini@gmail.com	Raw earth is a viable alternative to traditional energy intensive building materials like concrete and fired clayey materials. It can be locally sourced and serves as an excellent hygrothermal buffer, regulating indoor temperature and relative humidity. Unlike mainstream building materials, earth is also fully recyclable at the end of its life cycle. However, stabilisation – the addition of supplementary material to enhance mixture stability – is often required to enhance the durability of earthen building products and their resistance to liquid water erosion, typically increasing their environmental impact. To mitigate this impact, various bio-based stabilisation methods have recently been explored by the scientific community. These involve the addition of biopolymers, bio-fibres or the triggering of bio-mineralisation processes. Still, the effects of these novel bio-stabilisation methods on the mechanical and hygrothermal behaviour of earthen building composites/products require further investigation. This paper provides an overview of existing experimental methods for measuring the mechanical, hygroscopic and thermal properties of bio-stabilised earthen composites and products, along with key findings from the literature. Insights from this review can help guide future research on bio-stabilised earthen products.
13.05-13.25	**Mold growth in biostabilized earth construction materials: a potential ally in enhancing water durability**	Lily Walter, G. Medjigbodo, Y. Estevez , O. Nait-Rabah , L. Linguet	lily.walter@univ-eiffel.fr	Earth construction, primarily composed of inorganic soil, is a viable alternative to traditional energy-intensive building materials such as cement concrete. Biostabilization of earth construction materials, achieved by adding a biostabilizer (0.5–5% relative to soil mass), can enhance the material's strength and durability, particularly water resistance. Biostabilizers such as plant fibers, leaves, cactus mucilage, wood extracts, starch, and algae have been used in traditional construction practices and are now increasingly studied by the scientific community. Among the challenges of biostabilization is the susceptibility to mold growth, as biostabilizers serve as nutrient sources for microfungi that can develop under high humidity or water ingress. The effect of mold growth on biostabilized earth materials has been poorly studied and is generally considered harmful, particularly due to its impact on indoor air quality. This extended abstract summarizes a recently published study demonstrating the strong potential of mold mycelium—once heat-inactivated—to enhance the water durability of biostabilized earth materials without compromising air quality or material properties. These findings were based on an investigation of twenty earth mortar formulations, using two soil types and four biostabilizers (2% of soil mass). These results pave the way for a new paradigm—rethinking mold not as a threat, but as a potential co-builder in earth construction.
13.25-13.45	**Building with Earth: Unveiling Reaction Mechanisms in soil-cement Systems**	Ashish Bastola, Nicholas Benjamin Petersen, John Rushing, Pavan Akula	bastolaa@oregonstate.edu	Improvement in engineering performance of chemically stabilized soil is due to the reaction between reactive soil minerals and stabilizers. The pozzolanic products that form as a result of the reaction, such as calcium silicate hydrate, ettringite, and stratlingite, are responsible for the modification of treated soil. Formation and durability of these pozzolanic products are controlled by the pH and chemical composition of the pore solution of treated soil; however, there have been limited studies investigating the influence of pore solution chemistry on the performance of chemically stabilized soil. In this study, natural and simulant soil was treated with lime and cement. They were cured for up to 28 days, and pore solution was extracted at regular intervals. The pH and ionic composition of the solution was determined and used as input for thermodynamic modeling software to predict stability of the pozzolanic products. The results were validated through mineralogical characterization, such as XRD and TGA. Unconfined compressive strength measurements were conducted concurrently as a process monitoring tool. The thermodynamic model showed stability of CSH and ettringite in OPC cement and CSA cement, and this was verified through XRD and TGA. Therefore, pore solution chemistry has potential application in monitoring the performance of stabilized geomaterials over the course of their service life.
13.45-14.05	**Potential of Treating War-Polluted Soils for Earth-Based Construction in Ukraine**	Anna Pomazanna, Mykhailo Shevchenko, Oleksandr Bonchkovskyi	a.pomazanna@khsa.edu.ua	The study investigates the feasibility of repurposing soils contaminated by military activity in Kharkiv Oblast, Ukraine, as sustainable feedstock for post-conflict reconstruction. While research in Ukraine has centered on agricultural and ecological impacts of soil contamination, its role in post-war reconstruction remains largely unexamined. In this study, nine soil samples from two soil profiles were analysed for heavy-metal content. After conducting particle-size distribution analysis and performing field tests for earth-based materials on the loess sublayer from Kharkiv Oblast, two remediation strategies were piloted. The dilution strategy blends contaminated soils with secondary aggregates to reduce heavy-metal concentrations below regulatory thresholds while producing prototypes of compressed earth blocks (CEB). The encapsulation strategy encloses the contaminated core within protective insulation and clay or lime plaster layers, immobilizing residual metals through sorption and pH buffering. Both approaches demonstrated technical viability but face regulatory and methodological hurdles. Local resource constraints and the urgent need for standardized long-term leachate and dust-release protocols are also highlighted. These findings indicate that war-impacted soils can be transformed into safe, locally sourced building materials, thereby reducing landfill burdens and supporting low-carbon reconstruction in Ukraine.
14.05-14.25	**Bio-based fluidification of earth mortar using tannin addition**	Samuel Auger, Jean-Emmanuel Aubert, lily WALTER, Jean-Christophe GARRIGUES, Emile Perez	s_auger@insa-toulouse.fr	The construction sector accounts for approximately 40% of energy consumption and 20% of greenhouse gas emissions in France, primarily due to the use of cement. This could be mitigated by replacing cement with raw earth in many cases. However, performance and processing of raw earth need significant improvements to enable industrial-scale production. It is therefore essential to reduce water content while maintaining consistency. This study investigates the combination of two types of tannins with three different types of soils in both unmodified and alkaline environments, as alternatives to environmentally harmful chemical fluidizers. The pH of the mixing solutions was adjusted using sodium hydroxide. Consistency was quantified using a penetrometer. Results indicated that the addition of both tannins reduced the water content of all soils while maintaining consistency (–17% on average). In an alkaline environment, this effect was enhanced for kaolinite (–42%), whereas it diminished for smectite (–10%). For the soil rich in calcite, no significant change in behavior was observed between neutral and high pH levels (–28%). In the presence of too much tannin, a surface-active effect took place, aerating the mortar. This study validates the use of tannins to fluidify kaolinite, however it highlights that various soils react differently. Further investigations, such as zeta potential measurements, are needed to confirm the adsorption behavior of tannins, particularly for kaolinite in a basic environment, and to assess whether the basic conditions inhibit adsorption in the case of smectites.
14.25-14.45	**Exploring alternative stabilization for compressed earth blocks: a systematic literature review**	Ricardo Cruz, José Alexandre Bogas, Alessandra Ranesi, Paulina Faria	ricardojtcruz@tecnico.ulisboa.pt	Compressed earth blocks (CEB) are gaining attention as a sustainable alternative to traditional masonry units due to their low embodied energy, reduced carbon emissions and use of locally sourced materials. However, their vulnerability to water, particularly in regions with heavy rainfall and flooding, remains a major challenge. To address this, Portland cement is often used as a stabilizer, but its significant environmental impact has driven researchers to seek more sustainable alternatives. In response, recent studies have explored partial replacement of Portland cement with industrial by-products and wastes such as fly ash and ground granulated blast furnace slag. While some of these substitutions showed promising results, they still raise concerns. This systematic review evaluates the potential of stabilizing CEB solely with alternative reactive materials with low embodied energy. Using the PRISMA framework, relevant studies from the Web of Science database were analyzed. Findings indicate that both organic and inorganic alternative binders can substantially enhance the mechanical strength of unstabilized CEB. By highlighting eco-efficient stabilization strategies, this review contributes to advancing sustainable practices in earth-based construction.
14.45-15.05	**A combined laboratory and field study to assess the durability of CEBs against water-mediated weathering**	Rafail Panagiotou, Ioannis Ioannou	panagiotou.rafail@ucy.ac.cy	Water-mediated weathering is probably the main deterioration mechanism affecting earth-based building materials, in general, and Compressed Earth Blocks (CEBs), in particular. Among the water-mediated mechanisms affecting the performance of CEBs in use, wind-driven rain, rising damp and alternating wetting and drying cycles are the most prominent ones. In this study, spray erosion and drip tests were first conducted in the lab to assess the effect of wind-driven rain on CEBs consisting of 75% w/w soil and 25% w/w quarried sand. Furthermore, capillary absorption experiments and wet/dry cycles were carried out to investigate their response against rising damp and alternating wetting and drying, respectively. The results of the laboratory tests showed that the CEBs under investigation exhibited negligible erosion in spray erosion and drip tests, while they presented a comparatively low capillary absorption coefficient. Furthermore, they were resistant to alternating wetting and drying cycles. Following the laboratory tests, wallettes using the same CEBs were built and exposed to real environmental conditions in a rural environment. The wallettes were built on a stone foundation, following the traditional practice of earth building in Cyprus, to prevent them from being eroded due to direct contact with liquid water and the ground. The wallettes showed negligible erosion after an entire year of natural exposure. More specifically, no degradation was observed due to wind-driven rain, though localized erosion was evident in areas where surface run-off of water occurred. This was more severe on north- and west-facing facades, compared to east- and south-facing ones. The results of this study show that there is an agreement between the laboratory tests and the natural exposure of CEB wallettes, thus suggesting that the CEBs under investigation may be used locally to build contemporary structures, without being in severe danger of water-mediated erosion.

21-Oct

Room 1 - Earthen materials
DAY 2

Title	Authors	corresponding author's email	Abstract

12.45-13.05	**Sodium hexametaphosphate as superplasticizer for MgO-silicate cement stabilized clays**	Raphael Kuhn, Pietro Lura, Guillaume Habert, Ellina Bernard	raphael.kuhn@empa.ch	A good workability of clay-based building materials during mixing and placing is a key factor when building strong and durable structures. However, the flowability of clay mineral-based materials is impaired by stabilization with hydraulic binders such as Portland cement-based binder. While stabilization is essential to increase the mechanical properties and therefore cannot be omitted, it is possible to reduce the viscosity of the material with superplasticizers. Common clay superplasticizers such as sodium hexametaphosphate (NaHMP) are incompatible with Portland cement-based binder, as they considerably retard Portland cement hydration. Hence, stabilizers that are both compatible with clays and superplasticizers must be sought. In this study, the combination of NaHMP and MgO-silicate cement is tested as a potential superplasticizer and stabilizer for clay-rich materials. The influence on the rheology is investigated by rheometer measurements. The mechanism of action is analyzed based on the particle interactions using zeta potential and static light scattering (SLS). The sorption behavior of the superplasticizer is determined by 31P MAS ssNMR and pore solution analysis (ICP-OES and pH). It is shown that NaHMP adsorbs as a polyphosphate with different chain lengths. The polyphosphates induce an increased negative surface charge on the particles, which leads to strong electrostatic repulsion. This repulsion reduces the forces that must be overcome to fluidify the material and allows the desired workability to be achieved during casting of structural elements.
13.05-13.25	**Regenerative Retrofitting of Built Environment Assets Via Ecologically Active Soils**	Alejandro Jiménez Rios, Juliana Calabria-Holley, Francisco Javier Castila Pascual	ajr225@bath.ac.uk	It is estimated that 80% of the buildings that will exist in 2050 have already been constructed. However, many of these buildings perform poorly in terms of energy efficiency and fail to comply with net-positive solutions. Natural soil is a low-embodied energy, recyclable, and healthy material that has been used for millennia in our buildings, following vernacular traditions and sustainable practices. When enhanced to be ecologically active, soil can support plant growth, offering a path to retrofitting buildings that enhance thermal insulation, expand green urban surfaces, improve air quality, and elevate both aesthetics and occupant well-being. Soils are considered ecologically active if they can provide the necessary humidity level and nutrition conditions for plant germination and long-term viability. This paper presents the rationale and the objectives of the Regenerative Retrofitting Via Ecologically Active Soil Structures (Reeco-Soil) project, which aims to establish a comprehensive understanding of the state-of-the-art and regenerative potential of retrofitting built environment assets using ecologically active soil structures. The study employs a methodology based on PRISMA guidelines. Preliminary results are presented according to keyword clusters and publication year distribution, with approximately 70% published within the last decade, indicating a strong and current evidence base. Ultimately, this project aims to generate a flourishing relationship between humans and the living world by introducing a regenerative and innovative approach to building retrofitting.
13.25-13.45	**Bio-stabilisation of earthen materials: a perspective on the potential contribution to climate change adaptation and mitigation.**	Magda Posani, Guillaume Haber, Yannick Igor Fogue Djombou, Yi Du, Evy Vereecken, Pierre Esteve-Bourrel, Léo Pinchard, Alessia Emanuela Losini, Guilherme Barreto Arez Coelho, Lola Ben-Alon, Olga Beatrice Carcassi, Mansoure Dormohmadi, Alejandro Jiménez Rios, Muralidhar KAMATH, Michele Libralato, Joana Maia, Christina Makoundou, Bruno Malet-Damour, Alessandra Ranesi, Céline Perlot, Agostino Walter Bruno, Snežana Vucetic, Ana Margarida Armada Brás	magda.posani@gmail.com	With its potential for low embodied carbon, bio-stabilised earth offers a sustainable alternative to traditional carbon-intensive building materials. Moreover, unlike lime and cement stabilisation, bio-stabilisation methods hold the promise of improving the durability of earthen materials while retaining their moisture buffering capacity and recyclability. Despite the promising characteristics of bio-stabilised earth, research on the topic remains limited. The RILEM TC BEC aims to address this gap by advancing the understanding of bio-stabilisation. Its objectives include developing a classification system for bio-stabilisation techniques, examining their effects on the microstructure and chemical composition of earthen materials, and evaluating their macroscopic impact on mechanical and hygrothermal properties. The TC also aims to develop and promote a performance-based design approach for diverse applications of bio-stabilised earthen materials. Finally, the TC intends to evaluate the role of bio-stabilised earth constructions in climate change adaptation and mitigation strategies. This paper introduces the work of the RILEM TC BEC and presents findings from its literature review, focusing on the potential of bio-stabilised earth for climate change adaptation and mitigation.
13.45-14.05	**Recyclability of Soil Stabilised with Natural Hydraulic Lime for Earthen Constructions**	Chiara Turco, Elisabete Teixeira, Ricardo Mateus	id9631@alunos.uminho.pt	The construction sector has a significant impact on the environment through greenhouse gas emissions, energy consumption, resource depletion, and waste generation. In response, earth is increasingly recognised as a sustainable construction material due to its abundance, local availability, non-toxicity, and excellent hygroscopic properties. While research on earthen materials has underscored their environmental and thermo-hygrometric benefits, the recyclability of earth, particularly when stabilised with mineral binders, remains poorly understood. Stabilised soils are frequently regarded as less recyclable, yet their actual reuse potential has been scarcely investigated. This research investigates the recyclability of lime-stabilised soils, focusing on two soil types with different grain sizes. Two recycling methods were evaluated: recycling the stabilised soil without further modification and applying additional stabilisation in each cycle. These methods were tested for three recycling cycles to evaluate material behaviour and performance over time. The change in aggregate size after each cycle, compressive strength, and water absorption by capillarity were studied. The study found that additional stabilisation must be applied for recycling without downcycling previously stabilised soils. The results show that if the same amount of lime is applied at each cycle, the strength increases exponentially. Due to the irreversible nature of mineral stabilisation, it is recommended to use cementitious stabilisers only when necessary.
14.05-14.25	**Ultralight Earth: A Preliminary Look into Thermal Performance of Locally Sourced Fibre-Earth Composites**	Johanna Hyrkäs, Matti Kuittinen, Magda Posani	johanna.hyrkas@aalto.fi	This paper presents a preliminary investigation into ultralight earth (ULE) insulation materials developed using locally sourced clay and bio-fibres from Finnish agriculture and industrial side streams. The study responds to the urgent need for construction materials that have low carbon footprint and high carbon storage, supporting Finland's legally binding 2035 carbon neutrality target and broader bioeconomy objectives. Four ULE composites, based on rye straw, hemp shives, reed chaff, and recycled wood, were developed in collaboration with a local clay craftsperson and tested for dry density and thermal conductivity. The resulting materials exhibited dry densities below 450 kg/m^3, qualifying as ultralight, and achieved thermal conductivity values as low as 0.047 W/(m·K). These results are competitive with conventional insulation materials, such as mineral wool and expanded polystyrene. Notably, the straw-, reed-, and hemp-based ULEs met the thermal insulation threshold of 0.065 W/(m·K), as defined in European guidelines for ETICS, while all formulations qualified as thermal insulating mortars under EN 998-1:2017. These findings demonstrate the feasibility of ULE materials as sustainable alternatives for thermal insulation in subarctic climates. The study also lays the groundwork for future optimisation of mix designs to enhance performance and durability, paving the way for wider adoption in both new and renovated buildings. This work contributes to closing the knowledge gap on ULE applications in Nordic countries and supports a circular, low-carbon construction sector in Finland.

20-Oct

Room 2 - Cement, Cementitious materials, and Concrete
DAY 1

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Influence of Magneto-Rheological Response on Early Hydration and Microstructure in Cement Paste**	Feng Hu, Dengwu Jiao	hufeng0227@outlook.com	The rheological properties of concrete are crucial for its workability and mechanical performance, but the requirements may conflict at different stages of construction. For example, 3D concrete printing demands low yield stress and viscosity for pumpability, but higher static yield stress post-extrusion to prevent collapse. Therefore, it is necessary to regulate the rheological properties to balance these conflicting requirements. Magneto-rheological control is an innovative approach that involves adding magnetic particles to cementitious materials, with their movement and arrangement altered by an external magnetic field. This approach offers new possibilities for actively regulating the rheological properties of cementitious materials. However, the effects of magnetic fields and magnetic particles on early hydration and microstructure are not fully understood. To address this gap, this study investigates the impact of magneto-rheological response on the early hydration and microstructure in cement paste by adding magnetic particles and applying an external static magnetic field. The results show that the magnetic field induces a stronger magneto-rheological response with higher water to cement ratios, increased particle content, and smaller particle sizes. While it does not alter early hydration products, it densifies the microstructure by activating water molecules. Short-term exposure enhances early compressive strength when particle content is below 5%, but prolonged exposure or higher content causes anisotropy due to magnetic field gradients. These findings contribute to a better understanding of magneto-rheological control and its potential in construction applications.
13.05-13.25	**Investigation of carbonation for low carbon concretes under indoor, sheltered and unsheltered temperate climate using a diffusive method**	Ouijdane Qacami, Bruno Huet, Philippe Turcry, Karim Aït Mokhtar, Ravi A. Patel, Frank Dehn	ouijdane.qacami@holcim.com	Carbonation is a significant threat to concrete durability, driven primarily by gas diffusion. Pore water saturation, influenced by environmental conditions, plays a key role. Rain can saturate concrete pores and delay carbonation, while variations in relative humidity affect pore saturation and carbonation rates. In such scenarios, the classical square root of time model may not accurately represent the carbonation process. This study presents a non-destructive method to measure CO2 flux J at the concrete surface during atmospheric carbonation via CO2 diffusion. Flux data is used to calculate the diffusion resistance factor R=L/D, representing the ratio between carbonation depth L and the CO2 diffusion coefficient D of the carbonated zone. Knowing the concrete CO2 binding capacity, flux measurements are numerically integrated to determine carbonation depth. Three concretes with different curing durations, two low-carbon concretes and one conventional concrete, are monitored under natural carbonation in three exposures (controlled indoor chamber at 65% RH and 20°C, outdoor sheltered and unsheltered temperate climate) for six months. Concretes are designed to reach carbonation depths between 0 and 10 mm representative of field conditions. Correlations are observed between measured flux, relative humidity fluctuations and rain events. Concretes in indoor conditions showed higher diffusion resistance R compared to outdoor exposures. However, differences between sheltered and unsheltered samples varied over time. The data is used to develop a model linking instantaneous flux J of CO2 within the carbonated zone to the carbonation depth evolution under weathering effects, with the diffusion coefficient D expressed as a function of relative humidity, rain and curing conditions: J=D(Rain,RH,curing)/LΔ[CO2] Future work includes numerical modeling of the carbonation process based on this real-world data, advancing our understanding of concrete durability in diverse environments.
13.25-13.45	**Mixer power consumption as an indicator of water content and concrete properties**	Barbara Aboagye, Ryan Gosselin, William Wilson	barbara.aboagye@usherbrooke.ca	Variations in aggregate moisture and environmental conditions affect concrete mixing dynamics and concrete properties. As aggregate moisture measurement is still a challenge in some types of concrete plants, the power consumed by the mixer during concrete mixing can be used as a valuable information regarding the water content and concrete performance. The objective of this study is to explore the feasibility of using the power consumption curve as an indicator of water content and concrete properties. Six concrete mixtures with water contents varying between -15% to 15% of the nominal water content (183kg/m3) in increments of 5% were used in this study. An ammeter was used to measure the mixer power consumption during mixing. Power consumption curve features, such as loading peak power, fluidity power, and minimum power after loading peak showed a strong correlation with water content and concrete properties. A strong linear relationship was observed between water content and concrete properties such as slump (R^2 = 0.93), resistivity (R^2 = 0.98), and compressive strength at 1 day (R^2 = 0.88), 7 days (R^2 = 0.98), and 28 days (R^2 = 0.96). The results show the strong correlations between the power consumption curve, water content, and concrete performance, as well as the capacity of the curve to detect changes in concrete mixture consistency and performance. These findings show the potential of the power consumption curve as a real-time, non-invasive tool for monitoring water content and concrete properties.

13.45-14.05	**Micromechanical Modeling of Spatially Heterogeneous Interfacial Transition Zone (ITZ) in Recycled Aggregate Concrete**	Ahmed Shittu, Feng Li, Elske Linß, Florian Kleiner, Christiane Rößler, Luise Göbel	ahmed.olanrewaju.shittu@uni-weimar.de	The use of recycled aggregates (RA) in concrete has gained increasing atten-tion due to its potential to enhance sustainability in construction. However, the varying properties of different RAs can significantly impact concrete per-formance, both at the microstructural and macroscopic levels. A key factor in-fluencing mechanical behavior of concrete is the interfacial transition zone (ITZ), where aggregates interact with cement paste. The ITZ plays a crucial role in determining concrete's strength, durability, and overall performance. Despite its importance, many existing models oversimplify the ITZ as a uni-form layer, ignoring its actual variability. This study examines the impact of spatially varying ITZ properties in con-crete containing two different RAs, including abraded concrete aggregate (RCa) and recycled concrete aggregate (RCu). A micromechanical multiscale model is applied to represent the heterogeneous nature of concrete, spanning from the micrometer-scale of hydration products to the centimeter-scale of the bulk material. In addition to existing approaches, the present model incorpo-rates the non-uniform characteristics of the ITZ. Using insights from nanoindentation and SEM-EDX analyses, it was ob-served that ITZ thickness, porosity, and mechanical properties vary depend-ing on the type of RA and its interaction with the new cement paste. These variations are integrated into the micromechanical model, resulting in a more accurate analytical representation of the elastic and compressive behavior of concrete with recycled aggregates. This approach also enhances understand-ing of how different RAs influence the ITZ structure and, consequently, the overall material performance.
14.05-14.25	**Comparison between different methods of determining apparent elasticity modulus of cementitious materials**	Mauro José da Silva Filho, Ana Karoliny Lemos Bezerra, Thamires Ximenes Cavalcante, Lucas Feitosa de Albuquerque Lima Babadopulos, Jean-Claude Carret, Jorge Barbosa Soares	mauro.silva@det.ufc.br	This study aims to compare four different techniques for determining the apparent elasticity modulus of cementitious materials: Impact Resonance Testing (IRT), Ultrasonic Testing (UT), Static Modulus Testing (SM), and Dynamic Modulus Testing (DM). Tests were conducted on twelve cylindrical specimens comprising three conventional concretes (with and without superplasticizer), a high-performance concrete (HPC), and a cement mortar. The experimental campaign followed a sequential protocol: (i) initial characterization using UT; (ii) characterization using RM; (iii) after, evaluating the CM testing under sinusoidal loading; (iv) evaluating RM again, to check for microdamage associated with the tests and (v) final evaluating SM. All specimens were tested using the four techniques under the same conditions, allowing for direct comparison of the results. The IRT showed excellent agreement with the DM method, with differences of less than 1 GPa across all materials. The UT also presented good consistency, particularly for stiffer concretes, while the SM yielded lower average values and higher variability. Strong linear correlations were found (near-1 R^2 values) between IRT and the other testing methods analyzed. The findings confirm the potential of IRT as a reliable, fast, and non-destructive technique for evaluating the stiffness of cement-based materials. The methodology also proved effective in detecting modulus reductions caused by repeated loading cycles, especially in mortar specimens.
14.25-14.45	**Rheological and mechanical analysis of alkali-activated concretes with BSSF steel slag as precursor and aggregates**	Madson Souza, Abcael Melo, Lucas Babadopulos	madsonlucas@alu.ufc.br	The significant environmental impact associated with Portland cement production has driven the development of alkali-activated binders (AABs) as more sustainable alternatives. This study aimed to evaluate the rheological and mechanical properties of alkali-activated concretes (AACs) incorporating steel slag from the Baosteel Slag Short Flow (BSSF) process, used as a precursor and as aggregate for civil construction and infrastructure applications. Two BBSF-based AACs were produced using natural aggregates (AAC-N) and BSSF aggregates (AAC-B), and their performance was compared to Portland cement concretes made with natural (PCC-N) and BSSF (PCC-B) aggregates. Workability was assessed through rheometry and slump flow tests, while compressive strength tests were used to evaluate mechanical properties. Flow rheometry results confirmed that all concretes exhibited self-compacting behavior. AACs displayed pseudoplastic characteristics and required over three times the mixing energy of PCCs — attributed mainly to the higher viscosity of the alkaline activators — while PCCs exhibited Newtonian flow behavior. Notably, the substitution of natural aggregates with BSSF reduced the torque demand and did not significantly alter the overall rheological behavior. All concretes reached compressive strengths above 35 MPa at 28 days, with AAC-B and PCC-B reaching 42.1 MPa and 81.5 MPa, respectively. The incorporation of BSSF also led to an earlier increase in compressive strength, likely due to secondary reactions. These findings highlight the potential of BSSF as a sustainable and effective precursor and aggregate in AACs, supporting its use in civil construction and infrastructure applications.
14.45-15.00	**Quasistatic Crack Propagation in Cement-Based-Materials Induced by Pyrrhotite Oxidation**	Osamah Dehwah, Nicos Martys, Stephanie Watson, Edward Garboczi	osamah.dehwah@nist.gov	The deterioration of concrete foundations due to pyrrhotite oxidation has been a significant issue in Connecticut and Massachusetts, prompting numerous studies to better understand its underlying mechanisms and chemical reactions. Controlling the iron sulfide content in aggregate is crucial to mitigating this issue, as remediation costs are substantial. Pyrrhotite oxidation is a slow process, and while a few thousands of homes in Connecticut have been confirmed to have pyrrhotite-induced damage, the Connecticut Department of Housing estimates that up to thousands homes may have been built with pyrrhotite-bearing aggregate and could be susceptible to future deterioration. To investigate the impact of pyrrhotite oxidation on concrete deterioration, a quasistatic 2D finite element analysis was employed to simulate crack network development in cement-based materials. While a two-dimensional model cannot fully capture three-dimensional reality, it provides valuable insights into how microstructural features influence crack growth and how internal expansion mechanisms contribute to crack network patterns, and the associated degradation of concrete's elastic properties, including Young's, bulk, and shear moduli. In addition, a semi-empirical model was developed to establish the relationship between mechanical properties and crack area, providing a useful tool for understanding the patterns of concrete cracking due to internal phase expansion.

21-Oct

Room 2 - Cement, Cementitious materials, and Concrete
DAY 2

	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Synthesis and processing of dense tricalcium and dicalcium silicates for surface-sensitive characterization**	Aidyn Tugelbayev, Carlos A. Fortulan, David Jarret Wright, Carolina Tallon, Alexander Brand	aidyn@vt.edu	Tricalcium silicate (Ca3SiO5, C3S) and dicalcium silicate (Ca2SiO4, C2S) are the most critical mineral components in portland cement, governing early-age and long-term hydration and strength development. Understanding their structural and surface behavior is critical for advancing cement chemistry and improving concrete mechanical performance and durability. Currently, most studies rely on powder forms of calcium silicates that limit advanced surface analyses of these materials. This study addresses the need for bulk, low-porosity calcium silicate samples suitable for high-resolution surface characterization by presenting a robust, reproducible method for synthesizing dense polycrystalline C_3S and β-C_2S bulk specimens with 5 % to 8 % porosity. Mixtures of calcium carbonate and amorphous silica were sintered at 1450 °C and 1600 °C, with and without stabilizing ions, to produce dense polycrystalline β-C2S and monoclinic and triclinic C3S bodies, respectively. The powders were granulated with a polyvinyl butyral binder in isopropanol and compacted via cold isostatic pressing, followed by a final sintering step to ensure homogeneity. The study presents detailed optimization procedures for sample preparation, including binder selection, pressing conditions, and sintering protocols, while offering practical recommendations and troubleshooting guidance to address potential challenges, such as phase uniformity and polishing requirements. The polishing of the product yields samples with smooth surfaces suitable for surface-sensitive analyses and characterization of crystallographic orientation, including scanning electron microscopy (SEM) and electron backscatter diffraction (EBSD). By enabling consistent synthesis of dense calcium silicates, this work supports advanced experimental investigations into the microstructural evolution of cement phases, and contributes to the design of more sustainable and durable construction materials.
13.05-13.25	**Active Rheology Control of Cementitious Materials: Comparing Residual Materials with Potentially Magnetic Particles**	Paula Heik, Timon Echt, Fabian Ehle, Luise Göbel	paula.heik@uni-weimar.de	Active Rheology Control (ARC) represents an innovative concept to control the rheological behavior of cementitious materials. By incorporating magneto-responsive particles, rheological properties can be modified in a targeted manner through the application of an external magnetic field. However, many of the particles studied present challenges in terms of cost and availability, limiting their suitability for large-scale applications. Therefore, there is an increasing need to identify more economical and environmentally friendly alternatives. In this study, two different residual materials in the form of slags, representing promising candidates to exhibit magneto-responsive behavior, were investigated. Their magnetic properties were analyzed using vibrating sample magnetometry, while particle size distributions were determined by means of laser diffraction. Additionally, oscillatory rheometer tests with a magnetorheological device were used to evaluate the magnetorheological behavior of slag-including cement pastes. The results reveal that both slag materials exhibit a pronounced magnetorheological response, that is furthermore strongly dependent on the particle dosage. With these findings, the range of suitable materials for ARC expands, contributing to the development of more sustainable, eco-efficient cementitious systems with enhanced functional properties.
13.25-13.45	**Effects of blending water reducing admixtures (WRAs) on rheology and workability retention of limestone metakaolin blended cement**	Thien Tran, Daniel Benkeser, Kimberly Kurtis, Newell Washburn, Kejin Wang, Maria Juenger	thien.tran1@austin.utexas.edu	It is widely acknowledged that metakaolin in blended cements improves engineering properties and durability. However, it reduces the blend's fresh flowability and shortens slump retention time. In this investigation, three workability modifiers (WM) were used to fluidize a mixture of ASTM C595 Type IL cement containing 15 wt.% metakaolin, called limestone metakaolin-blended cement (LMC). The study aimed to use WMs and their combinations to curb the workability loss of the LMC system. Dosages of each WM and blends of them for the LMC system were determined in which the LMC reached neat-cement equivalent yield stress and similar flowability and workability retention. Compressive strength and heat of hydration were also studied to evaluate the impacts of the WMs on the LMC system. The results highlighted the possibility of using combinations of WMs to deal with the loss in the rheological performance of calcined clay limestone blended cement.
13.45-14.05	**Influence of partial replacement of cement by glass powder waste and glass microspheres on rheology of self-compacting concretes**	Abcael Melo, Madson Souza, Bruna Fideles, Francisca Paz, Kamila Guedes, Lucas Babadopulos	abcael.melo@alu.ufc.br	Self-compacting concrete (SCC) offers significant advantages in constructability due to its ability to flow and compact under its own weight without the need for vibration. However, its higher cement content compared to conventional concrete raises environmental concerns, particularly regarding carbon emissions. This study explored the partial replacement of Portland cement with glass-based materials - specifically angular glass powder waste (GP) and spherical glass microspheres (GM) - as a strategy to enhance the sustainability of SCC without compromising its rheological performance. SCCs were prepared with 10%, 20%, and 30% GP by weight, along with SCCs with GM at 10% and 20% to evaluate the effect of particle shape on rheological behavior. Rheological properties were assessed using a planetary rheometer. The results showed that neither GP nor GM replacements affected the classification of the concretes as self-compacting. All systems exhibited slight thixotropy and behaved similarly to Newtonian fluids. While the use of GP led to increased apparent viscosity due to its angular geometry and larger particle size, GM improved flowability due to its spherical morphology. Overall, the incorporation of glass-based waste materials proved to be a viable approach for producing more environmentally sustainable SCCs suitable for civil construction applications.
14.05-14.25	**Nanotechnology as a feasible strategy for sustainable precast concrete production**	Simone Rapelli, Denny Coffetti, Luigi Coppola	simone.rapelli@unibg.it	Nanotechnology, originally developed for high-tech applications, is increasingly being applied in the concrete sector. Among its various appli-cations, it provides a cost-effective solution to accelerate early-age compres-sive strength development, a critical requirement in precast concrete produc-tion, without increasing environmental impact or compromising the long-term durability. This study investigates the use of a C-S-H-based admixture to improve the economic and environmental sustainability, as well as manufacturing effi-ciency, of precast concrete. A conventional precast mixture was optimized by gradually reducing the cement content by up to 60 kg/m3, while incorpo-rating the seeding admixture. The experimental investigation included adia-batic calorimetry, compressive strength tests from 16 hours to 28 days, and simulations of environmental impact and production costs. The results demonstrate that the optimized mixtures achieved both early-age and long-term compressive strength targets, even with significantly lower cement content. Moreover, the optimized concretes exhibited a lower carbon footprint and production costs comparable to the reference mixture. These findings support the adoption of nanotechnology as a scalable and sustainable strategy to reduce the carbon footprint of precast concrete production.

20-Oct

Room 3 - Innovative, low-carbon materials
DAY 1

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Toward One-part Alkali-activated Low-grade Metakaolin via Inter-grinding: Assessing Reaction Kinetics and Nanostructure Evolution**	Meddelin Setiawan, Claire White	ms8898@princeton.edu	Developing alkali-activated materials (AAM) is one of the pathways to decarbonize cement manufacturing that currently contributes 5-8% of global anthropogenic carbon emissions. However, extensive deployment of AAMs in industry has yet to be realized, part of which is likely due to the reluctance to work with "two-part" activation that requires handling large amounts of concentrated caustic solutions. Here, we have developed a "one-part" AAM, where the dry mixture of precursor and activator is mixed with only water, resembling the hydration of OPC. Low-grade calcined kaolinitic clay (low-grade metakaolin) was chosen as the aluminosilicate precursor due to the global abundance of kaolinitic clays, making it more commercially attractive than the lower availability sources of fly ash and blast furnace slag. The focus of this work was to investigate the underlying physicochemical properties responsible for measured changes in reactivity, where the dry mixture was synthesized via inter-grinding in a planetary ball mill. It was found that inter-grinding increased the reaction kinetics and extent of alkali-activation reaction. Preliminary results have shown that inter-grinding caused broadening of particle size distribution and alteration of the bonding environment (nanostructure). Hence, this work aids in deepening our fundamental understanding of the formation behavior of "onepart" alkali-activated metakaolin and our future aim of tailoring larger-scale performance characteristics which are central to actualization of design codes and standards for AAM.
13.05-13.25	**A Novel Pathway to Low-Carbon Cements via Analcime Sand Valorisation**	Shubham Jain, Daniel A. Geddes, Micael Silva, Brant Walkley	shubham.jain@sheffield.ac.uk	The cement industry has a substantial carbon footprint, generating roughly 0.91 kg of CO2 for every kilogram of Portland cement produced and accounting for nearly 8% of global CO2 emissions. This necessitates a swift transition to more sustainable methods. Furthermore, the construction industry faces an increasingly urgent need to adopt low-carbon alternatives, such as supplementary cementitious materials and innovative clinker replacements, due to the growing demand for infrastructure and urbanisation. In recent years, the cement industry has seen widespread use of supplementary cementitious materials (SCMs) like fly ash (FA) and ground granulated blast furnace slag (GGBFS), which help to lower carbon emissions. These industrial by-products, originating from coal-fired power plants and steel production, respectively, improve cement properties and contribute to a reduced carbon footprint. However, a key challenge for the global cement industry, particularly in the UK and Europe, is the limited domestic supply of these traditional SCMs in many countries. Consequently, this scarcity requires the exploration of alternative and locally sourced resources to ensure a sustainable and resilient supply chain. Recognising this critical global need for alternative SCMs, this study investigated the potential of analcime sand, a by-product from lithium hydroxide production by Green Lithium Refining Ltd. (based in the UK), as a promising novel additive for cement and concrete in the construction industry and other sectors. Utilising this by-product not only aligns with circular economy principles but also offers a strategic advantage by leveraging material linked to a significant growth sector. Moreover, the domestic production of analcime sand would greatly benefit the British cement industry and economy. By decreasing reliance on imported SCMs, the cement industry can enhance its self-sufficiency, reduce transportation emissions, and contribute to regional economic development. The successful integration of analcime sand into low-carbon cement formulations would represent a significant advancement towards a more sustainable and environmentally responsible construction sector in the UK, with potential for global application. Despite the promising potential of analcime sand to reduce clinker usage and CO2 emissions, its application is currently hindered by insufficient research into its characteristics, reactivity and final properties of the analcime sand-blended cements. Therefore, this study thoroughly examined the physical and chemical characteristics of analcime sand to determine its potential as a novel cement additive or SCM. A comprehensive suite of analytical techniques such as particle size distribution (PSD), X-ray diffraction (XRD), zeta potential, scanning electron microscopy (SEM/EDX) etc. were used to determine the physical and chemical properties of analcime sand. Furthermore, the reactivity of analcime sand was assessed using rapid, relevant, and reliable (R3) tests with isothermal calorimetry. This work further explored the synthesis, fresh- and hardened-state properties, and characterisations of analcime sand-blended cementitious systems with varying cement replacement levels (0-50 wt.%). The results clearly indicate that analcime sand is suitable for incorporation into cementitious systems. Incorporating analcime sand as a partial cement replacement notably impacted the flowability of cementitious pastes. Furthermore, blended cement mortars achieved acceptable 28-day compressive strength up to a specific cement replacement level, suggesting potential for sustainable concrete production. Various characterisations of the blended cements revealed that analcime sand incorporation alters the cement matrix's chemical environment, pore structure, and phase composition. These findings have significant implications for advancing sustainable innovation, circular economy, and resource efficiency within the construction sector. Moreover, the potential applications extend beyond construction, opening up new avenues for sustainable practices across diverse industries.
13.25-13.45	**Predictive Modeling of Consistency Class Using Machine Learning Techniques on Industrial Concrete Datasets**	Abdelhamid HAFIDI, Benoit Hilloulin, Ilhame Harbouz, Ahmed Loukili, Ammar Yahia	abdelhamid.hafidi@USherbrooke.ca	In this study, we applied machine learning techniques to classify concrete into consistency classes, using real-world data provided by an industrial partner in France. The dataset includes over 480 different mixtures and more than 1,515 concrete samples, most of which incorporate supplementary cementitious materials (SCMs) such as slag and fillers. There are twelve input features and one output representing each of the five consistency classes. The machine learning models demonstrated strong performance, with the Light Gradient Boosting Machine emerging as the best performer, with an F1-score exceeding 88%. Using Shapley Additive Explanations, we identified the water-to-binder ratio, admixture dosage, and binder content as the most influential factors affecting the slump. Overall, this research underscores the potential of machine learning to enhance concrete mix design and promote more sustainable construction practices, though future work is needed to validate the models across diverse regions, raw materials, and mix designs to ensure broader applicability and robustness.
13.45-14.05	**A model material and an adapted protocol for the study of the shear thickening of low-carbon cement-based materials**	Clémentine Delattaignant, Hela Bessaies-Bey, Nicolas Roussel	clementine.delattaignant@univ-eiffel.fr	As W/C ratio is progressively decreasing, viscosity has become a major issue for sustainable concretes. Viscosity finds its origin in a Newtonian contribution induced by the shearing of the interstitial liquid and in a shear thickening contribution, the exact mechanism of which is still debated. In order to open new path for viscosity-reducing admixtures, we study in this work the shear thickening contribution to viscosity of model materials mimicking cement pastes. We develop a specific protocol allowing for the assessment of the shear thickening contribution at very high shear rates. At such rates, depending on the flow length scale, the material density and the resulting Reynolds number, inertia effects may be at the origin of turbulences inside the rheometer. These turbulences artificially increase the measured viscosity level and prevent from the exact quantification of material shear thickening. We therefore propose a selection of geometries and calibration procedures allowing for an extent of the shear rate range, in which the material shear thickening alone can be observed. Using the above protocol, we measure and isolate the shear thickening of calcite model pastes for various solid volume fractions. In a second step, we study the effect of comb copolymers on shear thickening. From our results, we discuss the role played by the polymer molecular parameters and surface coverage. Our results open the path for the design of viscosity-decreasing admixtures dedicated to low W/C sustainable concretes.
14.05-14.25	**Evolution of phase composition and pore water in fresh OPC paste during accelerated carbonation and natural carbonation**	Hao Yu, Lu Ge Cheng, Ryo Kurihara, Tung-Chai Ling, Ippei Maruyama	aprilyu@hnu.edu.cn	*Extended Abstracts (Abstract: Not shared - Missing copyright agreement)*
14.25-14.45	**Industrial-scale production of low-clinker LC3 cements using low-grade clays**	J. I. Galindo-Barajas, P. Perez-Cortes, M. A. Pérez, R. Gonzalez-Olmos, M. Guillem	jorgegalindob@iqs.url.edu	Clays and limestone are widely available materials used as supplementary cementitious material (SCM's) and filler, respectively, to reduce the clinker content in cement. The pozzolanic reactivity of clays is known to correlate directly with their kaolinite content; however, sourcing kaolinite-rich clays can be challenging in certain regions, despite the general abundance of clays deposits. This study investigates the feasibility of utilising low-kaolinite clays, in combination with limestone, for the production of low-clinker cements. The clays were calcined at 850 ºC and 950 ºC and subsequent characterisation was carried out via X-ray diffraction (XRD), thermogravimetric analysis (TGA), and X-ray fluorescence (XRF) to determine their mineralogical and chemical composition. Clay reactivity was assessed through the R3 test using isothermal calorimetry; in addition, the reactive silica content of selected clays was quantified. Finally, low-clinker cements incorporating calcined clay and limestone were produced at industrial scale. Their mechanical strength, setting times, and workability were evaluated. The results indicate that clays containing only 45% kaolinite can significantly contribute to the development of low-clinker cements, providing a viable alternative in regions where high-kaolinite clays are not readily available. Moreover, this study presents a practical approach to clay characterisation for industrial cement applications, which may serve as a useful reference for cement manufacturers interested in incorporating calcined clays into new products.
14.45-15.00	**Evaluating The Performance of Limestone Calcined Clay Cement (LC3) Incorporating Low-Kaolinite Clays from The Ceramic Industry**	Nesil Ozbakan Orhan, Derya Over	nesil_ozbakan@eskisehir.edu.tr	Clay, a globally abundant material, has the potential to serve as a cement substitute following calcination. Although the reactivity of kaolinitic clays in this process is well-established, further research is needed to fully understand the potential of low-grade clays with lower kaolinite content in cement production. This study investigated the potential of using clays with low kaolinite content (~22%) sourced from the ceramic industry in the production of limestone calcined clay cement (LC3) by calcining at 750 °C. The chemical composition of the clay was determined by X-ray fluorescence (XRF), and its mineralogical analysis was performed using X-ray diffraction (XRD). The mechanical properties of LC3 mortars were assessed at various water-to-binder ratios and different curing ages. Furthermore, the mineralogical composition of LC3 pastes was characterized using XRD analysis, while the microstructural development of LC3 mortars was investigated through scanning electron microscopy.

21-Oct

Room 3 - Innovative, low-carbon materials
DAY 2

	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Recycling fiber-reinforced polymer waste in the construction industry**	Huanyu Li, Jian Yang, Ning Zhang, Sohaib Nazar, Yiyan Ren, Lei Wang	unyu@163.com	With the production of FRP reaching approximately 2.56 million tons in In Europe by 2023, the disposal of CFRP and GFRP waste has become a significant environmental challenge. Our work explores the recycling methods and applications of FRP waste in civil engineering, focusing on their use as fine fillers, coarse aggregates, macro-fibers, and in various construction materials.
13.05-13.25	**Development of Alkali-Activated Lunar Regolith for Sustainable Space Construction**	Anas Driouich, Maria Chiara Dalconi, Claudia Esposito, Luca Valentini	anasdriouich@gmail.com	With the increasing emphasis on space exploration, global space agencies are advancing toward the establishment of human settlements on the Moon, which is considered as a pivotal step for future extraterrestrial missions. In this context, the In Situ Resource Utilization (ISRU) strategy promotes the use of local lunar resources, such as regolith, to produce durable building materials. Alkali activation of lunar regolith emerges as a promising approach, minimizing dependence on terrestrial supply chains by generating cementitious binders capable of withstanding lunar environmental conditions. This study explores the potential of using lunar regolith simulants to synthesize alkali-activated materials suitable for lunar construction, with a particular focus on optimizing their fresh and hardened properties. It was observed that the high content of reactive silica and alumina provided by metakaolin significantly enhances the formation of N-A-S-H gel phases, thereby increasing both yield stress and compressive strength. Response surface methodology revealed that under a defined optimal condition the material reached a yield stress of 19.77 Pa and a compressive strength of 27.6 MPa. Additionally, incorporating 3% urea as an admixture markedly improved workability and reactivity, enabling a reduced liquid-to-solid ratio and enhanced compressive strength. Preliminary vacuum-curing tests simulating lunar environments further emphasized the importance of optimizing water content and additive selection to minimize void content and maintain dimensional stability under low-pressure conditions. This work represents a critical advancement toward sustainable lunar infrastructure, contributing both to scientific knowledge and practical applications in extraterrestrial engineering.

13.25-13.45	**Porosity investigations of metakaolin based geopolymers**	Carlotta Pacente, Giulia Masi, Lucia Ferrari, Elisa Franzoni, Maria Bignozzi	carlotta.pacente2@unibo.it	Ordinary Portland Cement (OPC) is widely used in construction and is responsible for 5–8% of global CO_2 emissions. To date, the challenge is to find alternative sustainable solutions to traditional binders. Alkali-activated materials (AAMs) and geopolymers (GP) are among the most promising ones for this purpose, due to their fast-hardening at room temperature curing. This study aims to evaluate the correlation between microstructure and mechanical properties of geopolymeric binders based on metakaolin (MK) and ceramic tile waste (R), exploiting two different techniques such as mercury intrusion porosimetry (MIP) and 1H time domain-nuclear magnetic resonance (1H TD-NMR) for porosity investigations. The results highlight a significant increase in compressive strength development between 2 and 7 days, regardless the presence of ceramic waste. However, ceramic waste promotes lower compressive strengths than MK-based geopolymers for all the curing times in agreement with a broader pore size distribution in the range between 0.01-300 mm. 1H TD-NMR technique highlights that gel pore formation is delayed when ceramic waste is used as co-precursor, but similar refined nanopores structure are obtained after 2 days of curing, regardless the presence of ceramic waste.
13.45-14.05	**Key Mineralogical Events as Temperature Indicators in Microwave-Calcination of Palygorskite Clay**	Natacha Faria, Lincy Varghese, Raju Sharma, Moustapha Moustapha, Jean-Philippe Laviolette, William Wilson	natacha.nascimento@usherbrooke.ca	Microwave (MW) heating technology offers rapid, clean, and volumetric energy transfer, making it highly effective for thermal processing. Owing to these advantages, MW heating has been explored for various applications, with calcined clay being particularly notable due to its simple processing conditions. However, accurately determining the temperature achieved during MW heating remains challenging due to sensor incompatibility with electromagnetic fields, reliance on surface temperature measurements, and the presence of localized hot spots. This study investigates the mineralogical transformations of palygorskite clay using in situ high-temperature X-ray diffraction (HT-XRD) to identify key mineral events that can serve as temperature indicators during MW calcination. Thermogravimetric (DTG) analysis is conducted to further examine mineralogical transformations such as dehydroxylation and decarbonation. The results highlight notable transformations, including phase decomposition, dehydroxylation, and polymorphic transitions, as potential indicators of temperature during MW pyroprocessing. This approach offers a promising method for predicting temperature in MW calcination and contributes to the development of a database of suitable mineral candidates for MW-based pyroprocessing applications.
14.05-14.25	**Silicate solidified lunar regolith: A novel scheme from material properties to processing methods**	Zifan Geng, Guoqing Geng	gengzifan421@gmail.com	Extraterrestrial exploration, represented by Lunar base construction, has been promoted worldwide as a multi-disciplinary, cutting-edge and strategic issue. Originated from lunar geopolymers, we herein proposed a novel extraterrestrial construction scheme, silicate solidified lunar regolith (SSLR). It contains only 4 wt% of silicates, which no longer undergo geopolymerization but bind the particles through vacuum dehydration. Under this mechanism, various silicate modulus and modifications (inorganic, organic and physical modifications) have been detected to optimize the silicate adhesive. Through a simulated lunar environment combining high vacuum and large temperature variation, SSLR can be produced in both thermal and cryogenic vacuum, and it presents comprehensive durability with stable microstructures and over 70% of residual strength. Based on these material properties, this study further designed two processing methods for SSLR, mold-pressing and roll-pressing. In the former, a press mold along with water condensation recycle system was verified, and the influences of lunar regolith type, molding pressure and mortise-tenon fit relations are systematically revealed to study the mechanical properties of SSLR bricks and their assembly. In the latter, a specialized 3D printhead was designed for powder extrusion and passive roll-pressing. Therein, the roll-press effects, as well as the flexural and interfacial strengths of print layers are comprehensively investigated considering various roller-spring parameters, lunar regolith types and printing modes. This novel scheme will bring more prospects in both material and processing aspects for future lunar constructions.

20-Oct

Room 4 - Bio-based materials + <u>Heritage and Historic materials</u>
DAY 1

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Enhancing Olive Husk Properties Through Alkali, Thermal, and Biopolymer Treatments for Sustainable Building Applications**	Halima Belhadad, Ana Brás	belhadadhalima@outlook.fr	Olive husk (OH), a plentiful by-product of olive oil production, offers promising potential as a renewable aggregate in sustainable construction. This study investigates three modification pathways, alkali treatment with 6 % NaOH (ATOH), controlled thermal treatment (TTOH), and biopolymer coating with gum arabic (GAOH), to enhance OH's compatibility with cementitious and other mineral binders. The treatments were designed to reduce residual oil content and improve interfacial bonding while preserving OH's inherent dual structure, comprising compacted olive stones and a fibrous fraction. Performance was assessed against key application-oriented specifications: reduced hydrophobicity for improved binder adhesion, retention of particle integrity to maintain structural duality, low thermal conductivity for insulation efficiency, and optimised density/porosity balance to ensure lightweight performance without compromising durability. Characterisation, following RILEM TC 236-BBM protocols, included bulk density, porosity, thermal conductivity, water absorption, and particle size distribution, complemented by thermogravimetric/differential scanning calorimetry (TGA/DSC) and Fourier-transform infrared spectroscopy (FTIR). Thermal treatment achieved the lowest density (450.7 $kg \cdot m^{-3}$), highest porosity (54.0 %), and best insulation performance (λ = 0.0838 $W \cdot m^{-1} \cdot K^{-1}$). Alkali treatment markedly reduced oil content, improving microstructural integration despite higher water uptake (62.1 %), while GAOH yielded the densest structure (592.1 $kg \cdot m^{-3}$, 41.6 % porosity) with reduced water absorption (53.8 %) but higher conductivity (λ = 0.1024 $W \cdot m^{-1} \cdot K^{-1}$). Particle size analysis revealed fibre disaggregation for ATOH and TTOH, enhancing dispersion, whereas GAOH induced controlled agglomeration. Thermal and chemical analyses confirmed treatment-specific modifications, including lignin/hemicellulose reduction (ATOH), partial cellulose degradation (TTOH), and gum arabic–driven surface functionalisation (GAOH). These findings demonstrate that targeted treatments can tailor OH properties for integration into high-performance, lightweight, and thermally efficient bio-based composites.
13.05-13.25	**Enhancing Urban Biodiversity Through Bioreceptive Materials: Insights on Design, Properties, and Additive Manufacturing Applications**	Rafael Castillo, Maria De Los Angeles Ortega Del Rosario, Miguel Chen	rafael.castillo3@utp.ac.pa	Bioreceptivity refers to a material's capacity to support biological colonization without undergoing biodeterioration, a concept of growing relevance in engineering design. Current challenges in the architecture, engineering, and construction industry, like waste generation, CO2 emissions, water footprints, climate change, and increasing urbanization, have driven the search for strategies to mitigate these impacts. One promising approach involves promoting urban biodiversity by developing bioreceptive surfaces and facades, which have garnered recent attention. This work synthesizes findings from various studies on bioreceptive materials, emphasizing the intrinsic and extrinsic properties most relevant for effective design considerations. Key intrinsic factors influencing bioreceptivity include surface roughness, porosity, and chemical composition, though water retention remains the primary factor for biological growth. Bioreceptivity is also highly dependent on extrinsic environmental conditions such as humidity, air quality, and the availability of organisms in the surroundings, which must be considered during the design phase. In this sense, additive manufacturing (AM) emerges as a valuable tool for developing bioreceptive structures, as it can fabricate complex morphologies that support spore adhesion and biological colonization. Furthermore, experimental strategies, such as using organic waste and living materials, explore novel ways to enhance bioreceptivity while promoting ecological sustainability. This analysis emphasizes the integration of materials science, ecological principles, and innovative manufacturing techniques to enhance bioreceptive performance. These materials offer promising pathways for improving urban biodiversity and supporting ecological restoration efforts. This work aims to develop a comprehensive decision-making framework for engineers, designers, and architects, highlighting key parameters for promoting bioreceptive structures and fostering bio-inclusive urban spaces.
13.25-13.45	**Modelling Transport Phenomena of Cementitious Mortars made with bioPCM-Recycled Wood Aggregates.**	Hala Salhab, Sergio Nardini, Bernardo Buonomo, Vincenzo Bianco, Ignacio Peralta, Antonio Caggiano	hala.salhab@unicampania.it	This study investigates the thermal behavior and moisture transport phenomena by capillary action of sustainable cementitious composites made with recycled wood aggregates filled with bio-based phase change materials, aiming to enhance energy efficiency and durability in building applications. Two numerical models are developed and validated: an enthalpybased thermal model using the Apparent Calorific Capacity Method, and a moisture diffusion model based on Richards' equation and extended Darcy's law. Experimental data were obtained from three mortar types: i. ordinary Portland cement, ii. wood mortar, and iii. a third type fabricated with PCM–RWA aggregates labeled as "NRG-WOOD"—and used to benchmark the simulations. The thermal model successfully captured latent heat storage and release during heating and cooling cycles, while the hygric model accurately predicted capillary water absorption across all mixes. Notably, the NRGWOOD mortar exhibited significantly reduced water uptake (<5 kg/m^2), attributed to modified pore structures induced by PCM encapsulation, as reflected in elevated Raleigh-Ritz parameters. Both models showed strong agreement with experimental results without requiring post-calibration, underscoring their robustness and predictive reliability. This dual functionality—enhanced thermal regulation and reduced moisture ingress—highlights the potential of PCM–RWA composites as sustainable, high-performance building materials.
13.45-14.05	**Polylaminate Waste Valorisation into Mycelium-Based Composites for Sustainable Insulation Applications**	Joni Wildman, Walker Pete, Valeria Cascione, Daniel Henk, Andrew Shea	jlw89@bath.ac.uk	This study addresses two critical challenges in advancing a sustain-able and circular economy. The construction industry must transition to low-impact materials, as many conventional insulation materials deplete finite resources and have high embodied carbon. Sustainable, effective alternatives are essential to reduce both operational and embodied carbon of buildings. Concurrently, the world faces an increasing volume of waste; recycling options are often preferable to landfill and incineration but can impose environmental burdens. One problematic material is waste polylaminate carton (e.g. Tetra-Pak) which cannot be easily recycled alongside paper products, with the recycling process complex and region-dependent. Mycelium-based composites (MBCs) have emerged as a promising bio-based material capable of transforming lignocellulosic waste into effective insulation products. In their manufacture, fungal mycelium grows on a substrate, forming a natural adhesive as it colonises the material. Once fully colonised, the material is dried to kill the fungus and produce an inert material. While agricultural byproducts, such as straw and hemp-shiv, are common substrate choices, fungi can also grow on more complex waste streams, including polylaminate materials. In this study, the successful growth and binding of polylaminate waste with mycelium to produce MBCs is demonstrated. MBCs were produced using Lentinus tigrinus mycelium with hemp-polylaminate blends in ratios (by mass of hemp:polylaminate) of 1:0, 2:1, 1:2, and 0:1. Thermal conductivity (λ) measurements were conducted, with the measured thermal conductivity of the pure polylaminate MBCs λ = 0.035 ± 0.002 W/mK. Furthermore, increasing the proportion of polylaminate in the substrate blend did not significantly affect λ. Water absorption properties were also evaluated, showing that higher Tetra-Pak content led to reduced water absorption. Additionally, a life cycle assessment (LCA) was conducted, revealing that these materials exhibit a low global warming potential (GWP), suggesting they could be low-carbon alternative to conventional insulation. These findings highlight the potential of utilising complex waste streams from the food and beverage industry to produce mycelium-based insulation materials. This approach contributes to reducing environmental burdens associated with waste while promoting circular and sustainable practices within the construction sector.

14.05-14.25	**Climate-proof, climate-neutral renovations for the Finnish building stock**	Tayma Dadssi, Magda Posani	tayma.dadssi@aalto.fi	The climate-change induced rise in extreme weather events, such as heavy rains and heat waves, puts the hygrothermal performance of buildings in a critical situation. Nordic regions specifically, are facing more winter rainfall, and increasing humidity. This can lead to buildings' envelope components experiencing high moisture levels, resulting in increasing heating demand, thermal discomfort, and moisture-related degradation risks. Thermal insulation represents a renovation solution to improve the hygrothermal performance of building envelopes by reducing heat loss and promote moisture-safety. As so, it has the potential to increase the resilience of existing buildings to climate change. When using biobased insulation materials, the intervention also promotes a sustainable approach in construction, thanks to the carbon-negative footprints of these materials, together with the promise of reduction in operational emissions due to improved thermal performance of building envelopes. However, a deep, comprehensive understanding of the performance of locally available bio-based materials and their potential for moisture-safe renovations under current and future climatic conditions is needed to support the development of guidelines for bio-renovations. This provides a perspective on this matter, with a focus on the Finnish context.
14.25-14.45	**Carbonation Pathways of Mayan Engineering: Mineralogical Insights into Lime-Based Mortars from the Muyil Pyramid**	Md Montaseer Meraz, Pavan Akula, Francisco Javier Castaneda, Burkan Isgor	montaseer.meraz@gmail.com	The Mayans' skill in crafting highly durable lime-based mortars from natural in-situ materials highlights the sophistication of their engineering. Characterization of such mortars can provide valuable insights into the phases that contribute to long-term physicochemical performance. This study presents Mayan mortar's preliminary mineralogical characterization data collected from the Muyil pyramid (built around 300 B.C.) in Quintana Roo state of Mexico. Specifically, X-Ray Fluorescence, X-Ray Diffraction, and Thermogravimetric analysis of the mortar indicate that mortar primarily comprises lime and calcareous soil. The strength gain is attributed mainly to the binding of soil particles from calcite precipitation. Replicate mortar samples cast with lime and calcareous soil sourced from the Muyil region indicate that the calcium carbonate polymorphs present in the soil played a critical role in the kinetics of carbonation. The high concentrations of aragonite and calcite in the in-situ soil significantly enhance the carbonation kinetics. Experimental results suggest that aragonite and calcite act as nucleation sites, facilitating the improved kinetics of lime carbonation.
14.45-15.05	**Non-Destructive Methods for Assessing Hygric Properties in Heritage Masonry: Karsten and Pleyers tube**	Florian Verbruggen, Minting Chen, Evy Vereecken	florian.verbruggen@student.kuleuven.be	Determining hygric properties is essential for understanding and mitigating moisture-related risks in heritage masonry. Accurate knowledge of these properties is fundamental for evaluating the behaviour of masonry through numerical simulations. However, sampling in situ is often impractical or even out of the question in the context of heritage masonry due to the cultural and historical significance of such structures. Consequently, there is a pressing need to develop non-destructive techniques to reliably determine the hygric properties of heritage buildings. Therefore, this study explores non-destructive techniques, more specifically the Karsten tube and Pleyers tube tests, for assessing moisture transport and storage in heritage masonry. The research focuses on correlating non-destructive measurements with capillary absorption coefficients obtained through standardized laboratory methods, while also evaluating and refining existing analytical approaches. Particular attention is given to the three-dimensional moisture absorption behaviour of the Karsten tube, its impact on measurement accuracy and the potential added value of the Pleyers tube in this perspective. The findings confirm that non-destructive methods offer valuable insights into the hygric properties of masonry, providing a reliable alternative to traditional destructive techniques. By refining these methods, addressing 3D absorption effects, and ensuring consistency in their application, conservation professionals can enhance their ability to assess and mitigate moisture-related risks, contributing to the long-term preservation of architectural heritage.

21-Oct

Room 4 - 3D- printed materials + Heritage and Historic materials
DAY 2

	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Hygro-Tech: Towards high-tech, low-carbon building components for passive indoor humidity control**	Deng Jingyi, Magda Posani	djingyistudy@gmail.com	In northern Europe, relative humidity is expected to rise due to the changing climatic patterns, causing an increase in moisture-related issues in buildings. In this context, maintaining indoor relative humidity within the comfortable range of 40–60% is essential to reduce the risk of respiratory and spread of viruses among building occupants, while also helping preventing mould growth issues in the building envelope. While conventional HVAC systems are widely used to control indoor humidity, their high embodied and operational emissions pose significant environmental concerns. As a low-tech, low-carbon alternative, hygroscopic building materials offer a passive method of regulating indoor moisture. This work explores a new approach to this solution, considering high-tech production of low-carbon building panels made of hygroscopic bio-stabilised clay, to be used as autonomous humidity control material systems. These panels can be geometrically optimised to maximise surface exposure and enhance moisture buffering capacity. In this work existing literature is assessed and persisting gaps identified. Based on these outcomes, a potential methodology is developed to guide future research, providing a practical framework that integrates material science, digital design, building physics and environmental sustainability.
13.05-13.25	**Adaptation of low environmental impact mortar formulations for 3D printing**	Sourour Elleuch, Hélène Carré, Christian La Borderie	sourour.elleuch@univ-pau.fr	The construction industry is experiencing a transformative shift with the integration of 3D printing technologies, revolutionizing traditional construction methods. The growing adoption of 3D printing offers a promising approach to minimizing material waste, reducing manufacturing costs, and improving overall efficiency. However, 3D printable mortars often require a very high cement content and high dosage of admixtures compared to conventional mortars or concretes, which increases their carbon footprint. While 3D printing presents an opportunity to reduce waste and optimize material use, this challenge highlights the need for developing low environmental impact materials that maintain the required properties for successful additive construction. In this context, our research explores the advantages of combining low environmental impact materials with 3D printing to maximize the benefits of this innovative approach while addressing the environmental concerns associated with high cement content. Specifically, we focus on designing mortars that meet the rheological, mechanical, and environmental requirements for additive construction. Key parameters such as pumpability, buildability, and extrudability are targeted by selecting eco-friendly cement, fine calcareous filler, silica fume and sand. To ensure compatibility with 3D printing processes, we employ experimental methods such as rheological characterization, extrusion trials, and buildability tests. We adapt the formulation to ensure it possesses the necessary flow, workability, and setting properties required for extrusion and layer-by-layer construction. This adaptability to the 3D printing process is crucial, as it ensures the material can be successfully printed without compromising its performance or structural integrity. This research proposes a low-impact mortar that meet the technical demands of additive manufacturing while helping to reduce the environmental footprint of the construction industry.
13.25-13.45	**Extrusion-based 3D printing of fiber-reinforced concrete**	Haodao Li, Kamal Khayat	hlbb4@mst.edu	Embedding conventional reinforcement in 3D concrete printing (3DCP) remains a critical challenge due to the constraints imposed by the layer-wise deposition process. A promising solution is the incorporation of discontinuous short fibers into printable mixtures, as they can enhance tensile strength and toughness, mitigate the risk of shrinkage-induced cracking, and reduce crack width. In this study, three types of short fibers, namely 6-mm steel fiber, 8-mm polyvinyl alcohol (PVA) fiber, and 6-mm polypropylene (PP) fiber were incorporated into a high-performance printable mixture. The effects of individual and hybrid fibers on fresh properties, extrudability, mechanical performance, and shrinkage resistance were systematically evaluated. Results indicate that increasing steel fiber volume or partially replacing it with synthetic fibers significantly increased air content and accelerated early slump flow loss, despite improved water retention. Mixtures with up to 2% steel fibers maintained excellent printability, whereas hybrid fiber combinations introduced surface defects while remaining acceptable extrudability. The incorporation of hybrid fibers also increased mechanical anisotropy due to compromised filament quality. Drying shrinkage was most effectively mitigated by increasing the steel fiber volume, while partial reductions were observed with the incorporation of PP or PVA fibers. Overall, steel fibers provided optimal performance in balancing flowability, mechanical strength, and filament stability, while hybrid fiber strategies requires careful optimization to avoid print quality degradation.
13.45-14.05	**Correlating in-line sensor data to hardened state material properties in Digital Fabrication with Concrete**	Derk Bos, Arjen Deetman, Rob Wolfs	d.h.bos@tue.nl	High resolution quality control is essential for many digital concrete fabrication processes, since the systems used are often sensitive to disturbances and the objects that are produced more sensitive to defects when optimized towards material minimization. Furthermore, high-resolution quality control could decrease the uncertainty of the object's material properties and thereby reduce the cement consumption. In-line measurements are preferred over off-line or on-line measurements to obtain this high-resolution control, since it would require less labor, could be conducted at higher frequency, and would measure the same material that will later be placed in the product. However, the properties of the hardened state govern the quality of the finished concrete objects to a large extent. Since these properties are typically determined after 28 days or later, and tested using destructive, off-line methods, high-resolution quality control would be laborious and material intensive. Furthermore, making informed decisions based upon the results would be significantly delayed. To close this gap, this contribution aims to investigate whether there exists a correlation between in-line measured sensor data and off-line measured hardened state properties obtained at a later age. For the current study, a 3D concrete printing system is used that is equipped with various sensors. The material's strength is determined at the deposition age by the slugs test, and at an age of 15 minutes, 1.5 hours, 3 hours, 1 day, 2 days, 7 days, and 28 days by compression tests. For variations in the water-to-solids ratio, the results show that with increasing age the correlation between in-line quality indicators and the material's strength is decreasing. At deposition and ages of 15 minutes, 1.5 hours, and 3 hours, the R-squared adjusted is above 0.9. For 1 and 2 days, it is around 0.8, and for 7 and 28 days, a negligible correlation with and R-squared of around 0.2 is found, which can be attributed to a low sensitivity of the strength at these ages to variations in the water-to-solids ratio.
14.05-14.25	**3D printing of wood particle reinforced clay composite in direct ink writing**	Biva Gyawali, Kai Bentley, Pavan Akula, Kamran Alba, Vahid Nasir	gyawalb@oregonstate.edu	Additive manufacturing technology offers huge potential for practicing the circular economy, automation in construction, and mass customization in production. It offers freedom in the design, fabrication, and development of novel structures in construction. Environmentally sustainable construction can be promoted by utilizing forest-based products and earthen materials using this technique. There are several studies on the 3D printing of earthen-based material, such as clay, using natural fibers. However, the study on clay 3D printing using forest-based materials is limited. This study proposes optimizing formulations for 3D printing based on clay, wood particles, and water content. Furthermore, this research delves into the impact of printing parameters and materials (wood particles, water content) on the buildability of 3D-printed structures. The result shows that an increase in nozzle size, i.e., extrusion rate, shows a positive impact on buildability, while higher printing speed has a negative impact on buildability. Similarly, wood particles have shown a reinforcing effect, whereas higher water content has reduced the buildability height. The result shows that the average buildability of the mixture ranges from a minimum of 17 mm (mix design: clay, 5 wt.% wood particle, 0.5 wt. % xanthan gum, 70 wt.% water content printed at 90 mm/s using 3 mm nozzle diameter) to a maximum of 236 mm (mix design: clay, 10 wt.% wood particle, 0.5 wt.% xanthan gum, 50 wt.% water content printed at 30 mm/s using 6 mm nozzle diameter). Furthermore, this study briefly discusses the opportunities for future research in this field.

20-Oct

Room 5 - Structural and mechanical performance
DAY 1

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Low-velocity impact behavior of auxetic cementitious cellular composites (ACCCs)**	Jinbao Xie, Branko Šavija	J.Xie-1@tudelft.nl	Auxetic cementitious cellular composites (ACCCs) exhibit promising mechanical properties under static loading conditions, including high fracture resistance and effective energy dissipation. However, their performance under impact loading remains largely unexplored. In this study, two ACCCs—designated P25 and P50—featuring different aspect ratios were designed using additive manufacturing (AM)-assisted casting and evaluated under low-velocity impacts using a Schmidt hammer with consistent impact energy. Impact resistance was assessed based on energy absorption, localized damage, crack propagation, and peak reaction force. In addition to single-impact testing, multiple impacts were applied until specimen failure, with performance compared against a reference specimen incorporating circular holes. Strain distribution during impact was captured using Digital Image Correlation (DIC) with a high-speed camera. A numerical model accounting for strain rate effects was developed to simulate the impact behavior of the ACCCs. The results reveal that the ACCCs significantly outperformed the reference design in terms of impact resistance, showing reduced localized damage, increased contact stiffness, and enhanced energy absorption under multiple impacts. This improved performance is attributed to the auxetic behavior, which pulls more material into the impact zone, enhancing energy dispersion and minimizing localized damage, thereby preserving the overall structural integrity. Among the two designs, P50 demonstrated superior impact resistance due to its enhanced auxetic behavior, which engages more ligaments in energy dissipation and further reduces localized damage. Given the widespread availability of cementitious materials, this study highlights the potential of ACCCs as lightweight, high-performance protective structural materials for impact mitigation in infrastructure applications.
13.05-13.25	**Structural and energy retrofitting of masonry-infilled RC frames subjected to in-plane cyclic loading**	Matthildi Monastiridou, Szymon Cholostiakow, Lampros Koutas, Christos Papakonstantinou	mmonastiridou@uth.gr	Textile-Reinforced Mortar (TRM) has proven to be an effective strengthening solution for masonry-infilled reinforced concrete (RC) frames. Recent studies attempted to integrate TRM strengthening with standard thermal insulation, with promising results. However, the so-far solutions make use of ordinary portland cement-based binders (OPC), the production of which is a major contributor to global CO2 emissions. More sustainable mortars, such as those containing alkali-activated materials (e.g. geopolymers), can help address this issue, as recent studies have shown that they can offer similar or better performance than standard OPC mortars. This study aims to investigate the combination of structural and energy retrofitting of existing masonry-infilled RC frames. One-story, one-bay specimens were constructed at a 1:2.5 scale. Regarding the strengthened specimen, basalt fiber meshes embedded in metakaolin-based geopolymer mortar were used for structural retrofitting, while a conventional thermal insulation system with expanded polystyrene was used for energy retrofitting. The two specimens were subjected to in-plane cyclic loading.
13.25-13.45	**Point Cloud-Based Damage Detection for Reinforced Concrete Structures by Deep Learning**	Kazuma Shibano, Toma Tsubota, Moeka Mukai, Hiromu Tanaka, Hikaru Umezawa, Ninel Alver, Tetsuya Suzuki	kazuma3267@gmail.com	This study investigates the factors affecting crack detection accuracy using three-dimensional point clouds acquired by Terrestrial Laser Scanners (TLS). The research focuses on understanding how measurement conditions—including scanning distance, incidence angle, and point cloud density—influence the ranging results by TLS. In the crack detection procedure, PointNet architecture is employed for binary crack classification, with various input feature combinations evaluated including 3D coordinates, RGB values, intensity data and local geometric features derived from eigenvalue decomposition. Experiments were conducted on a reinforced concrete headworks structure constructed in 1976, using both TLS and Handheld Laser Scanner (HLS) measurements for ground truth validation. Results demonstrate that local geometric features significantly improve detection performance, achieving improvement of F1 score compared using only 3D coordinates. The study reveals that point cloud density, determined by scanning distance and incidence angle, critically affects ranging accuracy in the depth direction. Optimal neighborhood radius for local feature extraction varies between planar and curved surfaces. These findings provide practical guidance for improving crack detection accuracy in civil engineering applications using point cloud data and deep learning methods.
13.45-14.05	**GNP-Coated Aggregates for improving Concrete's Mechanical Properties.**	PAUL A. ABONGO, Myrsini E. Maglogianni	hw6300@wayne.edu	This study evaluates the performance of concrete incorporating graphene nanoplatelets (GNPs) as aggregate coatings compared to direct reinforcement. Concrete samples were prepared using natural aggregates, GNP-reinforced mixes, and GNP-coated aggregates. By employing highly dispersed GNP suspensions, a uniform aggregate coverage with less than 5% material loss during mixing was achieved. The compressive and flexural strength, as well as interfacial characteristics, were assessed using various GNP amounts to examine their influence on mechanical performance. Microstructural analyses using scanning electron microscopy (SEM) revealed the uniform dispersion of GNPs and their strong adhesion to aggregate surfaces, significantly contributing to improved mechanical properties. These findings highlight the transformative potential of GNP-coated aggregates in enhancing concrete's mechanical performance.
14.05-14.25	**Uniaxial Tensile Stress Relaxation and Cracking Behavior of SHCCs Incorporating Blast Furnace Slag and Fly Ash**	Faizudin Hafiz Zadah, Yao Luan	luanyao@mail.saitama-u.ac.jp	This study investigates the early-age (7 days) tensile stress relaxation and cracking behavior of slag- and fly ash-based strain-hardening cementitious composites (SHCCs) under sealed curing. Mechanical properties were characterized via compressive strength, Young's modulus, and uniaxial tensile tests, while stress relaxation was assessed under both pre-cracking (70% and 90% of the first cracking stress) and post-cracking (0.6% and 1.0% tensile strain) conditions. Crack formation and evolution were monitored using digital image correlation (DIC). Compared to fly ash-based SHCCs, slag-based SHCCs exhibited higher compressive strength and stiffness due to faster hydration and the development of a denser, more viscoelastic matrix. Both mixtures displayed ductile, strain-hardening behavior; however, slag-based SHCCs showed slightly superior tensile performance with higher strength and finer multiple cracking. Stress relaxation in slag mixes was more pronounced under both pre- and post-cracking conditions, particularly at higher stress levels, likely due to enhanced microcrack formation and fiber debonding. In contrast, fly ash-based SHCCs exhibited greater relaxation at lower stress levels. For both materials, the most significant stress decay occurred within the first 30 minutes, followed by a slower, stable phase. DIC analysis confirmed minimal change in existing crack geometry during relaxation, but revealed the initiation of new microcracks, especially in slag-based specimens, contributing to greater deformation and stress decay. These findings enhance the understanding of time-dependent tensile behavior in SHCCs and support their application in structural repair systems requiring long-term deformation control.
14.45-15.05	**Stochastic multi-hazard vulnerability assessment of railway masonry arch bridges subject to seismic and flood hazards**	Carlos Cabanzo, Monica Santamaria, Mitsuyoshi Akiyama, Paulo B. Lourenço, José C. Matos	carlos.cabanzo@civil.uminho.pt	Natural disasters are unavoidable and may lead to serious damage to transportation networks, often resulting in catastrophic losses. Masonry arch bridges (MABs) represent around 40% of the bridge stock in many European railway networks. In Portugal, MABs with larger spans and thinner piers were built during the early 20th century to improve the national network. These larger structures are expected to continue operating as a crucial part of the railway network without elevated maintenance costs. Moreover, some are located in regions with high seismic and flood hazards. The joint effects of these hazards in out-of-plane behavior are often overlooked, and their assessment may lead to identifying possible mitigation needs. The present research presents the vulnerability assessment accounting for the likelihood of both seismic and flood events to occur simultaneously on two large multi-span masonry arch bridges in Portugal. The results show the effects of the loss in stiffness due to asymmetrical scour in the out-of-plane failure mechanism of the masonry arch bridges. Fragility curves are obtained by considering structure-related uncertainties for different levels of intensity given by peak ground acceleration for the seismic hazard and flow discharge for the flood hazard. The resulting vulnerability curves, obtained by employing surrogate models, provide useful information for prioritizing assets considering their exposure to multiple hazards, thus aiding in maintaining the desired performance of the railway network.
	Performance and Evolution of Materials for 3D Construction Printing: An Overview from Conventional to Extreme Environments	Valentino Sangiorgio, Manuela Valeri, Cristina Cantagallo, Clara Adele Luise Guth, Francesco Salese	valentino.sangiorgio@unich.it	Additive manufacturing is revolutionizing the construction sector, from traditional residential buildings to emergency shelters and even extreme environments, by simplifying on-site operations. A critical challenge in this field is the development of sustainable materials for additive manufacturing. The housing crisis in low-income countries demands high-performance materials with simple, low-cost production cycles and locally available resources. Furthermore, 3D printing applications in extreme environments, such as deserts, polar regions, and planetary habitats, including those on the Moon or Mars, require innovative and printable material solutions. Several reviews exist on specific 3D printing material typologies, but a comprehensive overview focusing on material performance and production processes is still lacking. Accordingly, this study pursues two main objectives : (1) to deliver a critical review and comprehensive overview of innovative construction materials, analyzing their historical evolution, production cycles, mechanical, physical, and thermal properties, as well as sustainability and compatibility with 3D printing; (2) to integrate insights from the ArchiSpace project, funded by the European Union (MSCA Staff Exchange), which focuses on designing and constructing habitats in terrestrial analogs of planetary environments. A systematic literature review was conducted using an integrated approach combining qualitative analysis and bibliometric methods, offering a comprehensive overview of the state of the art in the field. As a result, a major gap identified is the understanding of geopolymer matrix properties, particularly regarding mix design, performances, and 3D printing processes. This dual focus on terrestrial and extraterrestrial applications highlights the transformative potential of 3D printing and provides a roadmap for future research and implementations in traditional and extreme environments.

21-Oct

Room 5 - Durability and degradation phenomena + **_Bituminus materials_**
DAY 2

TIME	Title	Authors	corresponding author's email	Abstract
12.45-13.05	**Durability Performance of Ternary Blended Self-Consolidating Concrete: A Comparative Study with Portland Limestone Cement-based SCC**	Timothy Kofi Ametefe, Mark Bediako	tkametefe@csir.brri.org	The construction industry increasingly emphasizes sustainability and durability, especially in concrete technology, due to environmental concerns associated with cement production and the need for resilient infrastructure. A broader study which adopted the simplex centroid mixture design approach developed a self-consolidating concrete (SCC) mix with a ternary mixed binder, optimizing the content of waste glass powder (GP) and low-grade calcined clay (CC). The goal was to develop a more sustainable and durable SCC by reducing the reliance on traditional cement and divert glass waste from landfills. For this study, two types of concrete mixes were prepared: a control SCC mix (CM) with Portland limestone cement (PLC) as the only binder and another with the ternary mixed binder (TM). The ternary blend constituted of 73% PLC, 21% GP and 6% CC. The durability performance including water absorption, sorptivity, resistance to acid attack and rapid chloride permeability were evaluated over curing periods of 28, 56 and 90 days and compared with the control mix. Results indicate that TM had consistently lower water absorption (up to 13%), reduced initial sorptivity (up to 19%), and significantly better resistance to chloride ingress and acid attack compared to CM. The ternary blended SCC mix was found to be a more durable alternative to conventional PLC-based SCC, with reduced permeability and improved resistance to chemical attacks.

13.05-13.25	**How to Protect Our Façade Coating Mortars? A Glance at Different Approaches to Improve Surface Protection**	Jéssica D. Bersch, Angela B. Masuero, Denise Dal Molin, Inês Flores-Colen	jessica.d.bersch@tecnico.ulisboa.pt	This study addresses the challenge of protecting building façades by evaluating lime-based coating mortars treated with thirteen surface finishes, including silicate paints and commercial hydrophobic, oleophobic, and photocatalytic products. The goal was to identify the most effective surface protection solutions by assessing multiple performance aspects, particularly self-cleaning and anti-graffiti capabilities. A straightforward assessment framework was established, focusing on key surface properties to support decision-making. Initial evaluations included measurements of gloss, chromatic coordinates, static water contact angle, and roughness. Subsequently, specimens were stained with methylene blue and exposed to ultraviolet light for 145 hours to evaluate self-cleaning performance via color change monitoring. A graffiti removal was then conducted, using silver spray paint and steam cleaning, with the cleaning efficiency assessed using an established scale. At 60°, gloss was highest for the anti-graffiti coating, though all values were generally low. Overall, color compatibility was preserved. Hydrophobic behavior was observed in silicate and hydrophobic treatments, while most photocatalytic coatings showed hydrophilic properties. The lime-based photocatalytic paint demonstrated the best self-cleaning performance, and, as expected, anti-graffiti coatings were most effective in graffiti removal. Some non-photocatalytic coatings also led to color changes under light, and one photocatalytic treatment provided partial resistance to graffiti. The findings underscore the need for additional research on rain exposure and long-term durability. At this stage, selecting a suitable coating depends on environmental exposure and anticipated degradation agents.
13.25-13.45	**Comparison between different total sulfur measurement techniques for the screening of aggregates with potential oxidation issues from iron sulfide minerals**	Dip Banik, Alexander Brand	dipbanik@vt.edu	Presence of pyrrhotite is a major issue for concrete durability due to the oxidation potential. To screen potential deleterious aggregates, European Standard EN 12620 and the Massachusetts Department of Transportation recommend a limit of 1.0 % total sulfur in any concrete aggregate and a limit of 0.1 % total sulfur when pyrrhotite has been identified in the aggregate as the primary screening method. This research explores the variations observed when total sulfur is measured by high temperature combustion, X-ray fluorescence technique and acid digestion. During combustion method, the presence of clay minerals creates melts with the potentiality of trapping part of sulfur in it and preventing it from reaching IR detectors. Though the types of sulfur containing minerals are not of importance for the combustion test, X-ray fluorescence techniques are susceptible to it as the sulfur chemical state influence the sulfur peak position and peak intensity. Thus, the combustion technique showed higher sulfur content compared to the X-ray fluorescence techniques. Acid digestion has the potential of sulfur leaving the aliquot by forming H2S gas during the digestion process and showing variabilities in results when compared to the combustion method.
13.45-14.05	**Effect of modification conditions on recovery and non-recoverable creep compliance of polymer-modified bitumen**	Simona Bitarytė, Audrius Vaitkus, Judita Škulteckė	simona.bitaryte@vilniustech.lt	To investigate the influence of styrene-butadiene-styrene (SBS) polymer on the rheological properties of bitumen, researchers modified virgin bitumen with SBS under controlled laboratory conditions using a high-shear mixer. However, there is currently no standardized procedure for bitumen modification with SBS; as a result, different researchers apply varying conditions. This study aims to determine the impact of modification parameterssuch as temperature, mixing time, and mixing speed—on recovery and non-recoverable creep compliance (as measured by the multiple stress creep and recovery test) at 60 °C for polymer-modified bitumen. For this purpose, 70/100 penetration-grade virgin bitumen was modified with 3.0% SBS at 185 °C using a laboratory high-shear mixer. The modification was conducted for different durations (1, 2, and 3 hours) and at various rotation speeds: 4000 rpm, 6000 rpm, and a combination of 6000 rpm followed by 300 rpm. Additionally, for the 1-hour modification, various speeds (ranging from 5000 to 6000 rpm) and temperatures were tested. The results showed that both the rotation speed and the modification duration significantly affected the recovery and non-recoverable creep compliance of the polymer-modified bitumen. The study revealed that, depending on the modification conditions, the creep and recovery properties of the modified bitumen could vary by more than a factor of two. These findings highlight the importance of carefully controlling modification time, mixing speed, and temperature when modifying bitumen with polymer using a high-shear mixer in laboratory settings.
14.05-14.25	**Determination of Complex Modulus from a Back-Analysis Process of Frequency Response Functions for Asphalt Mixtures using FEM modeling**	Thamires Ximenes Cavalcante, Ana Karoliny Lemos Bezerra, Mauro José Da Silva Filho, Lucas Babadopulos, Jean-Claude Carret	thamires.ximenes-cavalcante.2@ens.etsmtl.ca	This paper presents a method to determine the complex modulus of asphalt mixtures (AM) from Frequency Response Functions (FRFs) using a back-analysis approach. The main objective was to optimize the process for obtaining the linear viscoelastic (LVE) properties of AM based on non-destructive impact resonance test (IRT) data. The methodology combines an optimization code developed in MATLAB with numerical simulations in COMSOL, using the Finite Element Method (FEM) in 2D and the 2S2P1D rheological model to simulate the LVE behavior. The combined use of MATLAB and COMSOL allowed for efficient integration between numerical simulation and the optimization process, resulting in a more robust and automated methodology for analyzing viscoelastic materials. The results obtained from the IRT were compared with those from the Tension-Compression test (TCT). A good agreement was observed between the results of both tests, demonstrating the effectiveness of the proposed method. The expected impact of this research is to contribute to the advancement of computational tools for material characterization in engineering, with potential applications in road infrastructure projects and other related fields.