Conference Agenda

WED 26 Aug | THU 27 Aug | FRI 28 Aug

Daily Overview

Date: Friday, 28/Aug/2026

9:00am - 10:30am

KS 03: Keynote lectures
Location: POT 81
Session Chair: **Moslem Shahverdi**
Session Chair: **Elyas Ghafoori**
Speakers: Carmelo Gentile and Juliane Wagner

10:30am - 11:00am

Coffee break
Location: Exhibition and Catering Rooms: BEY E39, E26, 126

11:00am - 12:30pm

MS07-1: Distributed fiber optic strain sensing for bridge structural health monitoring
Location: POT 151
Session Chair: **Bertram Richter**
Session Chair: **Steffen Marx**

Distributed fibre optic sensors for bridge health measurements: from small to large scale

Biliszczuk, Jan[1]; Bednarski, Łukasz[2]; Sieńko, Rafał[3]; Teichgraeber, Marco[1]; Zuziak, Katarzyna[4]; Howiacki, Tomasz[4]
1: Faculty of Civil Engineering, Wrocław University of Technology, pl. Grunwaldzki 11, 50-377 Wrocław, Poland; 2: Faculty of Mechanical Engineering and Robotics, AGH University of Kraków, Mickiewicza 30, 30-059 Kraków, Poland; 3: Faculty of Civil Engineering, Cracow University of Technology, Warszawska 24, 31-155 Kraków, Poland; 4: SHM System | Nerve-Sensors, Libertów, Jana Pawła II 82A, 30-444 Kraków, Poland; th@shmsystem.pl

Structural health monitoring of bridges using distributed fiber optic sensing

Arulananthan, Gowshikan; Wu, Chao-sheng; Bhuiyan, Md Mehedi Hassan; Nate, Opperman; Blum, Hannah B.; Hampton, Jesse C.
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Long-term baseline stability assessment of a BOTDA-based fiber optic sensing textile for bridge monitoring

Cui, Guoqiang[1]; Wu, Rui[1]; Cao, Lidan[1]; Abedin, Sabrina[1]; Abazarsa, Maryam[2]; Cao, Lucas[3]; Yu, Tzuyang[2]; Wang, Xingwei[1]
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Realtime DFOS based SHM of a highway bridge

Künzel, Andreas[1]; Tomann, Christoph[2]
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Distributed fiber optic sensors as part of a hybrid structural health monitoring system of an extradosed bridge

Piątek, Bartosz[1]; Siwowski, Tomasz[1]; Olaszek, Piotr[2]; Sakowski, Artur[2]; Sieńko, Rafał[3]; Bednarski, Łukasz[4]
1: Rzeszow University of Technology, Poland; 2: Road and Bridge Research Institute, Poland; 3: Cracow University of Technology, Poland; 4: AGH University of Krakow, Poland; piatek@prz.edu.pl

Correction of temperature-induced effects in distributed fiber optic strain measurements

Dohnalík, Petr; Boros, Vazul; Vorwagner, Alois; Lachinger, Stefan
Austrian Institute of Technology, Austria; Petr.Dohnalik@ait.ac.at

11:00am - 12:30pm

MS14: Post-disaster bridge assessment – an integrated approach from monitoring to number crunching
Location: BEY E40
Session Chair: **Michael Polter**
Session Chair: **Tobias Mansperger**
Session Chair: **Karsten Menzel**

UAV-based data acquisition for structural digital twins

Lüdicke, Emilie[1]; Alt, Maximilian[1]; Pöhlmann, Frank[1]; Polter, Michael[2]
1: Cloud-Vermessung + Planung GmbH, Germany; 2: Technische Universität Dresden, Dresden, Germany; michael.polter@tu-dresden.de

An IFC 4.3 ontology hidden damages framework and Python ingestion pipeline for hidden bridge damage representation

Nisal, mukta; Karsten, Menzel
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Damage detection with statFEM-VFM

Morini, Andrea; Urrea-Quintero, Jorge-Humberto; Wessels, Henning
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Continuous coda wave based monitoring of the Nibelungenbrücke Worms

Epple, Niklas[1,2]; Hau, Julia[1,2]; Fontoura Barroso, Daniel[1,2]; Focht, Sven[1,2]
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Physics-informed transformer for real-time bridge deflection estimation using sensor fusion

Cho, Youn Sang; An, Yun-Kyu
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Post blast behavior of damaged reinforced concrete slabs strengthened/retroffited with NSM bars

Asad, Juwairia; Khan, Asad-Ur-Rehman; Fareed, Shamsoon
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11:00am - 12:30pm

MS20: Earth observation and other remote sensing methods for infrastructure monitoring

Location: **BEY 127**
Session Chair: **Alois Vorwagner**
Session Chair: **Vazul Boros**
Session Chair: **Maria Pina Limongelli**
Session Chair: **Antje Thiele**
Session Chair: **Lydia Puttkamer**
Session Chair: **Iris Hindersmann**
7th Session Chair: Stammler, Melanie / Bundesanstalt für Straßen..., DE 8th Session Chair: Rüffer, Jürgen / ALLSAT GmbH, DE

BBD-V: A national, transport-focused ground motion monitoring service in Germany

Stammler, Melanie[1]; Afonso, Tiago[1]; Brcic, Ramon[2]; Cziudai-Sonntag, Felix[1]; Dörr, Nils[3]; Katharina, Fricke[4]; Hiller, Johannes[1]; Kalia, Andre[5]; Konen, Lars[5]; Navarro-Sanchez, Victor[2]; Preußler, Vreni[4]; Jonas, Ziemer[5]; Florian, Zimmermann[6]
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Structural health monitoring of flood protection structures through improved InSAR processing

Dohnalík, Petr[1]; Boros, Vazul[1]; Kwapisz, Maciej[1]; Leopold, Philip[1]; Vorwagner, Alois[1]; Thiele, Antje[2]; Evers, Madeline[2]
1: Austrian Institute of Technology, Austria; 2: Fraunhofer-IOSB, Germany; Petr.Dohnalik@ait.ac.at

Strategies for monitoring bridge portfolios by radar satellites

Boros, Vazul[1]; Kwapisz, Maciej[1]; Leopold, Philip[1]; Kolomaznik, Jan[2]; Hlvacova, Ivana[2]; Martínez, César[3]
1: Austrian Institute of Technology, Austria; 2: GISAT, Czechia; 3: Bernard Gruppe, Austria; vazul.boros@ait.ac.at

Interpreting InSAR-derived bridge displacements through a calibrated finite element model

Liuzzo, Riccardo[1]; Brasca, Andrea[1]; Celli, Gaia[1]; Giordano, Pier Francesco[1]; Limongelli, Maria Pina[1]; Piscini, Andrea[2]
1: Politecnico di Milano, Italy; 2: SINA S.p.A, Italy; riccardo.liuzzo@polimi.it

Design and implementation of a multi-channel ultra-low-power IoT-based strain monitoring system with edge computing and precise time synchronization

Tong, Jian-Hua[1]; Lin, Yi-Ching[2]
1: Department of Intelligent Technology and Application, Hungkuang University, Taiwan; 2: Department of Civil Engineering, National Chung Hsing University, Taiwan; jhtong.hk@gmail.com

Raman spectroscopy-based stress monitoring of nuclear containment structures

Ha Eun, Park; Myung Soo, Kang; Yun-Kyu, An
Sejong University, Republic of Korea (South Korea); gkdms246722@sju.ac.kr

11:00am - 12:30pm

MS21: Bio-based materials for seismic retrofit of existing structures – enhancing structural performance and environmental sustainability

Location: **BEY E17**
Session Chair: **Antonio Formisano**
Session Chair: **Emilia Meglio**
Session Chair: **Massimiliano Gioffre**
Session Chair: **Chiara Pepi**
Session Chair: **Marius Mosoarca**
Session Chair: **Francesca Roscini**

Re-engineering traditional binders: CO_2-driven transformation of nano-enhanced lime mortars

Shahpari, Mehran; Gioffrè, Massimiliano
University of Perugia, Italy; mehran.shahpari@dottorandi.unipg.it

Mechanical response of masonry walls strengthened by hybrid natural textile reinforced mortar

Paolillo, Bruno[1]; do Nascimento Farias, Lidianne[2]; Pepe, Marco[1]; Martinelli, Enzo[1]; Toedo Filho, Romildo Dias[2]
1: Department of Civil Engineering, University of Salerno, Italy; 2: Federal University of Rio de Janeiro, Brazil; brpaolillo@unisa.it

Diagonal compression tests on masonry walls strengthened with natural TRM: scale effects and retrofitting efficiency

Stochino, Flavio[1]; Majumder, Arnas[1]; Valdes, Monica[1]; Concu, Giovanna[1]; Pepe, Marco[2]; Martinelli, Enzo[2]
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Durability of jute fiber-reinforced mortars in masonry panels under natural weathering

Farias, Lidianne do Nascimento[1]; Paolillo, Bruno[1,2]; Lima, Paulo Roberto Lopes[1,3]; Pepe, Marco[2]; Toledo Filho, Romildo Dias[1]
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Performance-based seismic retrofit of RC buildings using self-centering rocking frames

Mottola, Salvatore; Ferraioli, Massimiliano; Pecorari, Osvaldo
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Seismic resilience assessment of buildings using a fuzzy set approach

Rezaei Ranjbar, Parvane; Ferraioli, Massimiliano
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11:00am - 12:30pm

MS24-1: Non-destructive testing and monitoring of timber structures

Location: **POT 51**
Session Chair: **Cristoforo Demartino**
Session Chair: **Michele Mirra**
Session Chair: **Vittoria Borghese**
Session Chair: **Angelo Aloisio**
Session Chair: **Martina Sciomenta**
Session Chair: **Antonio Sandoli**
7th Session Chair: Riggio, Mariapaola / Oregon State University, US

Knowledge gaps and fire behavior of deadwood

Stochino, Flavio[1]; Zucca, Marco[1]; Borghese, Vittoria[2]; Demartino, Cristoforo[3]
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Structural assessment and service life modeling of historic timber foundations in Amsterdam

Mirra, Michele[1]; Pagella, Giorgio[2]; Ravenshorst, Geert[2]; Gard, Wolfgang[2]; van de Kuilen, Jan-Willem[2,3]
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Integrated seismic assessment of a 19th century timber gate structure in Japan

Xu, Chenpeng; Fujita, Kaori; Toyoda, Takahiro; Seike, Tsuyoshi
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Non-destructive assessment of secondary and virgin timber

Vonk, Niels; Borghese, Vittoria; Lontra, Bernardo; Niederwestberg, Jan
Netherlands Organisation for Applied Scientific Research (TNO), Molengraaffsingel 8, Delft, 2629 JD, The Netherlands; vittoria.borghese@tno.nl

Non-destructive testing of thermal-eensity properties in chestnut wood

Santoro, Luca[1]; Borghese, Vittoria[2]; Tromba, Ludovica[1]; Dongdong, Chen[3]; Sesana, Raffaella[1]; Vonk, Niels[2]
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Gamma irradiation of timber: safety and mechanical effects

Aloisio, Angelo[1]; Wang, Yue[2]; Scifo, Jessica[3]; Carcione, Rocco[3]; Cemmi, Alessia[3]; Niederwestberg, Jan[4]; Borghese, Vittoria[4]
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11:00am - 12:30pm

MS30-1: Video-based and imaging techniques for structural monitoring

Location: **BEY 138**
Session Chair: **Ivan Roselli**
Session Chair: **Stefano De Santis**
Session Chair: **Marialuigia Sangirardi**
Session Chair: **Alessandro Zona**

Analysis of algorithms for real-time dynamic structural monitoring through computer-vision

Allegrezza, Francesco[1]; Micozzi, Fabio[1]; Morici, Michele[2]; Zona, Alessandro[2]; Dall'Asta, Andrea[1,3]
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Internal and external cameras for vision-based monitoring of buildings during shake-table tests

Gioiella, Laura[1]; Micozzi, Fabio[1]; McBain, Morgan[2]; Morici, Michele[1]; Zona, Alessandro[1]; Dall'Asta, Andrea[3]; Simpson, Barbara G.[2]; Barbosa, Andre R.[4]
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Modal identification by phase-based motion magnification and comparison with classical methods

Caione, Giovanni; Liberatore, Domenico
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Insights into the dynamic behaviour of an elevated water tank from computer vision-based SHM

Sangirardi, Marialuigia[1]; De Santis, Stefano[2]; De Felice, Gianmarco[2]
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Structural health monitoring of civil infrastructure with neuromorphic cameras

Cazzato, Dario[1]; Vaglica, Giovanni[2]; Bono, Flavio[1]
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Using motion capture and DIC for the monitoring of masonry structures under testing

Léonard, Suzanne[1]; Archez, Julien[1]; Cumunel, Gwendal[1]; Terrade, Benjamin[2]; Colas, Anne-Sophie[3]; Garnier, Denis[1]
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11:00am - 12:30pm

MS32: Crowdsourced and indirect approaches to structural health monitoring

Location: **BEY 117**
Session Chair: **Maria Pina Limongelli**
Session Chair: **Thomas Matarazzo**
Session Chair: **Zhenkun Li**
Session Chair: **Chul-Woo Kim**

Mobile crowdsensing for structural health monitoring: field validation

Rezvani Alile, Mohsen; Giordano, Pier Francesco; Limongelli, Maria Pina
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A hybrid drive-by framework towards integrated bridge health monitoring

Irawan, Joshua; Kim, Chul-Woo
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Fleet monitoring of bridges using drive-by operational deflection shapes

Feng, Kun[1]; Fayyad, Tahreer[2]; Taylor, Su[3]; Li, Zhenkun[4]
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Pavement settlement identification from vehicle vibrations

Yanarom, Pattharaphong; Irawan, Joshua; Kim, Chul-Woo
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A crowdsensing-based approach for footbridge frequency identification using pedestrian response

Li, Zhenkun[1]; Ozer, Ekin[2,3]; Ereiz, Suzana[1]; Malekjafarian, Abdollah[2,4]; Limongelli, Maria Pina[1]
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Self-sensing in smart structures through mineral-impregnated carbon fiber reinforcements

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11:00am - 12:30pm

PS3: Advanced cementitious and composite materials

Location: **BEY 245**
Session Chair: **Silke Scheerer**

Effects of chemical admixtures on self-sensing cementitious composites: a review

B.L.P. e Silva, João; Wang, Chao; Das, Oisik; Sas, Gabriel; Gonzalez-Libreros, Jaime
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Recent studies have significantly advanced the development of new Self-sensing Cementitious Composites (SSCC) for Structural Health Monitoring (SHM), enabling their application in infrastructures such as bridges, tunnels, roads, dams and high-rise buildings. However, to increase the conductivity of SSCC, electrical materials based on metals or carbon need to be incorporated into the cement matrix, which can affect its properties in the fresh and hardened states. This scenario demands the use of

chemical admixtures, such as superplasticizers and water-reducing agents. In this sense, the current research takes a theoretical approach, based on a review, to consolidate the main findings regarding the use of chemical admixtures in cementitious composites and comparing their electrical properties using normalized resistivity. In general, previous studies have shown that admixtures have contributed to the dispersion and homogenization of conductive materials, which improves the formation of electrical networks. While accelerators, corrosion inhibitors and conventional water reducers combined with accelerators generally reduce resistivity by increasing ionic conductivity, shrinkage-reducing, air-entraining, high-range water-reducing, and retarding admixtures tend to increase resistivity due to changes in pore structure and reduced ionic mobility. However, limited data, interactions with conductive fillers, and variability in electrical testing methods restrict direct comparisons, highlighting the need for improved electrochemical characterization and standardized measurement approaches. Therefore, the compilation and analysis of these main findings helped to identify new approaches and challenges that contribute for the improvement of SSCC and its applications in SHM, due to the chemical admixture's effects.

Bicomponent PP fibers with chemical surface functionalization for enhanced bonding in cementitious composites

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The application of thin layers of strain hardening cementitious composites (SHCC) offers great potential to improve the impact resistance of existing buildings. Polypropylene (PP) fibers are commonly used for crack control in concrete. They also demonstrated their potential as a viable and sustainable alternative to expensive high-performance fibers in SHCC, like for example polyvinyl alcohol (PVA) or ultra-high molecular weight polyethylene (UHMW-PE) fibers. However, despite their numerous benefits in cement-based composites, they present a significant drawback: their low wettability. This not only leads to a reduced composite performance because of the inferior bonding behaviors between fiber and matrix, but also to problems during mixing, e.g., balling and fiber agglomeration, reducing the threshold for the maximum fiber content percentage. A potential solution to address this issue may be the reduction of their water contact angle, which typically exceeds 95°.

A possible strategy consists of the incorporation of additives, that are specifically designed to improve the bonding between PP and more hydrophilic materials. However, these additives are usually composed of PP grafted with functional groups and possess a significantly lower molecular weight compared to PP used for fiber spinning. However, to achieve high tensile strength in the fibers, a high molecular weight is indispensable. In this work we present a potential solution by spinning bicomponent fibers, where the additives are solely used as an admixture within the fiber shell. Consequently, we can incorporate significantly higher additive concentrations compared to the typical applications when using monocomponent fibers and achieve a much higher compatibility with the cementitious matrix while ensuring a stable spinning process and the tensile strength of the fibers. First, the requirements for a good spinnability for these bicomponent fibers are discussed by conducting rheology measurements, molecular weight analysis and thermal analysis. Then, the possible improvement of the wetting is discussed by surface functional group analysis as well as contact angle analysis. Subsequently, first spinning trials with a small-scale piston spinning device to produce bicomponent fibers are performed.

Investigation of bio-inspired layered interphases in carbon fiber-reinforced concrete using µ-CT

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Structural rehabilitation is a sustainable way to extend the service life of existing infrastructure. Carbon fiber-reinforced concrete (CFRC) is especially well-suited for this due to its application flexibility, such as through shotcrete in combination with flexible carbon grids. This allows for the reproduction of, for instance, curved surfaces without altering the existing structure's visual appearance. Moreover, the corrosion resistance of carbon fibers eliminates the need for a thick concrete cover. However, a critical challenge remains: brittle failure mechanisms, particularly the debonding and spalling of the concrete matrix from the carbon reinforcement. This study addresses this limitation by developing a bio-inspired interphase between the carbon reinforcement and the concrete matrix.

Our approach draws inspiration from natural materials with exceptional mechanical properties, such as nacre ("Brick and Mortar" structure, BnM) and glass-sponge filaments ("Layer by Layer" structure, LbL). Self-assembled BnM-structures were created using mixtures of montmorillonite (MMT) and a polymer. LbL-structures were formed through alternating layers of sodium water-glass and a polymer. These structures were applied to single fibers via dip-coating, employing different polymers with varying stiffness. For yarns, an impregnation procedure was utilized. The LbL-approach required multiple treatment steps to achieve the alternating organic and inorganic layers in both cases. Treated single fibers were embedded in a concrete matrix droplet for single fiber pull-out (SFPO) tests. Results showed that LbL interphases with increasing layer counts led to a decrease in interfacial shear strength but an increase in the required pull-out work, depending on the polymer stiffness. A BnM-structure with a polymer-to-MMT ratio of 6:4 also exhibited enhanced pull-out work compared to tests using the single components alone. Scanning electron microscopy (SEM) provided insights into the self-assembled surface structure and confirmed beneficial bonding at the interphase, evidenced by residues visible on the pulled-out fiber and within the pull-out cavity. The quality of the yarn impregnation was investigated

by computer tomography (CT), which revealed different wetting behaviors resulting in varied yarn and interphase morphologies. Finally, yarn pull-out (YPO) tests showed equally high results for impregnations with the stiffest polymer and a BnM-structure of this polymer with MMT in a ratio of 9 : 1.

Analysis of concrete penetration into microstructured impregnation of carbon textiles

Flechsig, Lissy[1]; Liebold, Frank[2]; Reißig, Silvia[3,4]; Mechtcherine, Viktor[3,4]; Scheffler, Christina[1,3,4]

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Strong bonding between carbon fabric and concrete is crucial for the effective performance of carbon concrete as a reinforcement system. To ensure the efficient utilization of the high-performance filaments, the fiber bundles must be impregnated to enable full force transfer between the individual filaments. This impregnation is often polymer-based, for example epoxy resins.

One disadvantage of this method is the insufficient interaction between the polymer impregnation and the concrete matrix, which can result in premature, brittle failure. Such failure phenomena typically manifest as delamination of the concrete cover. Therefore, a microstructured interface between the impregnated textile and the concrete matrix is necessary to improve the bonding via mechanical interlocking. For this purpose, epoxy resin is processed into a porous structure, which allows the concrete matrix to penetrate. This study quantitatively investigates the penetration of concrete into the pore structure of the interphase using micro-computed tomography (µ-CT). Samples are produced under defined conditions and are measured using µ-CT in order to obtain voxel data. Image processing and segmentation are then performed to analyze the porosity, pore size distribution and local penetration depth of a limestone calcined clay cement (LC3) matrix into the microstructured interphase.

Sensitivity of DIC-based tensile modulus of elasticity evaluation in ultra-high-performance concrete at low strain levels

Plößer, Maurice; Grzesiak, Szymon; de Sousa, Christoph; Pahn, Matthias

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Digital image correlation (DIC) is becoming more common for measuring strain in ultra-high performance concrete (UHPC). However, evaluating low elastic strains remains challenging. The high stiffness of UHPC means that elastic strains are often close to the noise level of DIC, making the results highly sensitive to the evaluation strategy chosen. This study investigates how the DIC-based evaluation methods influence the determination of elastic strains in direct tensile tests on UHPC. The effects of virtual gauge length, cut position, region-of-interest definition and smoothing strategies are quantified. The results demonstrate that elastic strains derived from DIC can vary significantly depending on the evaluation parameters, even within the linear elastic range. A sensitivity analysis is conducted and recommendations are made to enable the tensile modulus of elasticity (MOE) of UHPC to be determined robustly at low strain levels. The analysis underlines the importance of evaluating the stress-strain behavior at multiple load levels and with a maximum virtual gauge length that excludes the peripheral areas. The MOE can be determined using the secant modulus or trend line slope, provided that the dispersion of the strain values remains limited.

Machine learning-based prediction of compressive strength in 3D concrete printing: a multi-layer perceptron approach

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advantages over conventional casting methods, including reduced material waste, lower transportation costs, elimination of formwork requirements, accelerated construction times, and enhanced design flexibility for complex geometries. Whilst numerous experimental investigations in the literature have examined the mechanical properties of 3DCP elements, their widespread adoption in real-world projects remains limited due to insufficient design guidelines and predictive tools for assessing printed concrete behaviour at the design stage. This study presents an effective application of the Multi-Layer Perceptron (MLP) machine learning algorithm to predict the compressive strength of 3D-printed concrete based on mix design constituents. For this purpose, an experimental dataset has been collected from literature for compressive strength tests of 3D-printed concrete specimens. The performance of the MLP model is optimised through systematic hyperparameter tuning via random search methodology to establish appropriate parameter ranges. Additionally, 10-fold cross-validation is employed to mitigate overfitting risks and enhance model generalisation. The developed MLP model's performance is validated against experimental data, with the objective of providing designers with reliable computational tools to facilitate broader adoption of 3DCP technology in future construction projects. Furthermore, a sensitivity analysis is carried out to explore the influence of mix design components on the strength of 3D printed concrete.

11:00am - 12:30pm

PS5: Structural strengthening, retrofit and structural resilience

Location: **POT 112**

The impact of macro-synthetic and micro steel fibers on reinforced concrete beam behavior

DEBBAKH, Said[1]; ARIBI, Chouaib[1]; BAROUR, Sabiha[2]; khitem HANI, Houda[2]; FARES, Fathia[2]

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Strengthening methods for axially-loaded reinforced concrete columns against impact

Taheri, Ghazaleh[1]; Hu, Chentaoya[2]; Schubert, Thomas[1]; Unger, Nicholas[1]; Máca, Petr[3]; Mechtcherine, Viktor[2]; Beckmann, Birgit[1]; Scheerer, Silke[1]
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Seismic retrofit strategy based on self-centering rocking frames

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Mitigating progressive collapse in a steel–RC hospital via outrigger-belt truss retrofit

Ferraioli, Massimiliano; Ahmad, Tahir; Lavino, Angelo; Mandara, Alberto
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Determination of the stiffness of GFRP under axial compression using digital image correlation (DIC)

Basters, René; Grzesiak, Szymon; de Sousa, Christoph; Pahn, Matthias
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Progressive collapse vulnerability of steel storage racks: insights from testing and FEM analysis

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12:30pm - 2:00pm

Lunch break
Location: **Neue Mensa**

2:00pm - 4:00pm

MS01: Structural health monitoring and assessment of aging railway infrastructures
Location: **BEY E40**
Session Chair: **Chao Wang**
Session Chair: **Zhanchong Shi**
Session Chair: **Jaime Gonzalez-Libreros**
Session Chair: **Gabriel Sas**

Aging railway infrastructures increasingly suffer from fatigue, corrosion and cracking as a result of prolonged service, harsh environments and growing traffic loads. This Mini Symposium invites researchers and industry practitioners to explore state-of-the-art structural health monitoring (SHM) and assessment strategies tailored to these vulnerable systems. The aim is to drive scalable, sustainable solutions to extend infrastructure life, enhance safety, and optimize rail network management. Key topics are advanced sensing technologies (fiber-optic, wireless networks, UAV-based inspection); data analytics and machine-learning diagnostics; digital twins and life-cycle assessment models; predictive and condition-based maintenance strategies; integration of multi-sensor data and standards development; real-world case studies and implementation challenges; and risk assessment and decision-support tools.

Methods of indirect monitoring of deflection, load, and stresses on bridges

Ryjáček, Pavel[1]; Šach, Matěj[1]; Kolínský, Vojtěch[1]; Zralá, Daniela[1]; Vích, Daniel[2]; Klokočník, Petr[2]
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The subject of this paper is the current findings and insights of the SRIMS - TM05000045 Smart Railway Infrastructure Monitoring System project. The analysis of railway administration needs is described, and possibilities for long-term monitoring of degradation or damage to certain structures in railway infrastructure are presented. The proposed concept of affordable and widely applicable measurement of shifts in the supporting structure in the area of bearings is described, working with the possibility of correlating deflections and stress oscillations in the middle of the span with shifts in the bearing. Findings from experiments conducted with the aim of compiling stress spectra and monitoring damage accumulation are presented.

Operational applications of continuous strain monitoring on prestressed beam-girder bridges

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Concrete beam-girder decks prestressed by post-tensioning are a widely used typology of structure for road bridges. In Europe, many of them were built between the 1960’ and 1980’ and now reach the theoretical lifetime they were designed for. In addition, this typology of bridge decks undergoes specific ageing effects which can weaken their loading capacity, like loss of prestress load, prestress cable corrosion, and concrete cracking and spalling. To address the issue of maintaining this wide asset portfolio in operation while keeping the failure risk minimal, Structural Health Monitoring (SHM) including

alert systems and the release of synthetic health indices is gaining interest nowadays, since the reliability of the sensors and the anomaly detection methods have become mature. This contribution describes the feedback of SHM carried out from continuous strain measurements on post-tensioned prestress beam-girder road bridges on some recent case studies in France and Italy. The useful information obtained by the asset managers from the SHM and the related methodologies are presented, including operational results like Bridge-Weigh-in-Motion (B-WIM) to assess the real level of traffic loads, health indices from statistical analysis of large quantities of measurement data, and anomaly assessment on one example of a damaged bridge.

From data to insight: anomaly detection with 6D monitoring for bridge bearings

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Ensuring long-term safety and functionality of bridges requires smart, cost-efficient monitoring solutions. This paper presents a two-step anomaly detection framework for bridge bearings using the SuessCo 6D sensor, which simultaneously captures displacements, rotations, and temperature at the bearing. In the first step, classical correlation analysis establishes baseline relationships between thermal effects and mechanical response, enabling automatic detection of deviations from expected behaviour. In the second step, AI-based methods identify time-dependent behavioural changes that cannot be captured by temperature or inter-sensor correlations alone. The proposed approach transforms data-rich bridge monitoring into information-rich systems, enabling early fault detection, reducing maintenance effort, and supporting data-driven decisions for safer and longer-lasting infrastructure.

Pressure Distribution at the Ballast–Concrete Interface in a Full Scale RC Trough Bridge

Gonzalez-Libreros, Jaime[1]; Sarmiento, Silvia[1]; Wang, Chao[1]; Elfgren, Lennart[1]; Höjsten, Tommy[2]; Enoksson, Ola[2]; Andersson, Lars-Olof[2]; Sas, Gabriel[1]
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In ballasted reinforced concrete bridges, the way loads are transmitted through the ballast to the concrete slab plays a critical role in structural performance. However, most current design standards assume a simplified uniform load distribution, which does not accurately reflect real conditions. Past studies mainly focused on sleeper-ballast or ballast-sub-ballast interfaces, leaving the load transfer at the ballast-concrete interface poorly understood. This paper addresses the gap by testing a full-scale reinforced concrete trough bridge, a typical structural type found along European railway lines. The bridge was subjected to controlled static and cyclic loading, simulating real railway traffic in the Iron Ore Line which connects Luleå, Sweden to Narvik, Norway. Custom load plates were installed at the ballast-concrete interface to directly measure contact pressures. The results presented focus on the influence of ballast compaction, represented here in terms of the number of simulated load cycles, on pressure distribution. The data collected is analyzed to evaluate existing distribution models. Main findings highlight that ballast compaction and cumulative repeated loading influence pressure distribution, emphasizing the importance of detailed monitoring and further experimental research to incorporate evolving patterns on structural condition assessment and design of ballasted bridges.

Condition assessment of steel bridges – experimental and numerical procedures

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Most of the railway bridges in the Indian Railway system that have been built several decades ago and have deteriorated both in terms of strength and stiffness due to a variety of reasons. These bridges have been designed for live loads and service conditions that have changed drastically with time. Increased axle loads and traffic density have necessitated bridge owners to get the bridge condition assessed to determine their residual structural strength and identify strengthening measures to be taken for safe performance. Condition assessment provides information regarding the intensity and extent of observed defects, the cause for these defects and possible deterioration processes that have strong impact on the safety and service life of structures. Furthermore, this information forms the basis for estimating the residual structural capacity and possible remedial work that needs to be undertaken. The present study focuses on three bridges, a single span truss bridge, a three span open web girder bridge and a two long-span open web girder bridge in the Indian Railway zone. The axle load till a few years ago was classified as 18 ton axle load has undergone an upward revision to 22 t axle based on an in-house assessment of the Indian Railways. At present, there has been a growth in freight traffic in this section, for iron ore and coal movement, and the Indian Railways is considering a further enhancing the axle load to 25 t immediately with additional upward revisions later. The study reports on a suite of experiments in the form of measurements of strains, deflections, acceleration measurements and tilts for different loading scenarios, static and dynamic loads tractive measurements under brake bound tests. A finite element simulation of the tests offers a framework for comparisons to draw insights and confidence in the capability of the numerical methods, thus offering an alternate platform for structural response assessment.

Fatigue assessment of railway noise barriers based on field monitoring, ML-driven stress prediction and numerical modeling

Liu, Dongyun; Wang, Chao; Gonzalez-Libreros, Jaime; Elfgren, Lennart; Sas, Gabriel

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Railway noise barriers are frequently subjected to train-induced aerodynamic loads during long-term service, which may lead to fatigue problems at the welded base of steel posts. Conventional fatigue assessment methods often fail to account for the complex operational and environmental conditions experienced by real structures. To address this issue, this study proposes a fatigue evaluation framework that integrates long-term field monitoring data with machine learning (ML) and numerical simulation. Based on a field test database, a data-driven calculation model was developed to predict the stress responses of barrier steel posts under actual operational and environmental conditions. A finite element (FE) model validated by field data was further used to establish a quantitative relationship between the monitored stress responses and the maximum stress at the steel post base. Fatigue life for weld toe and weld root failure modes was evaluated using Palmgren-Miner linear damage rule and the nominal stress method in the Eurocode. Results show that weld root failure governs the fatigue performance of the steel post base, with significantly shorter fatigue lives than weld toe failure. Nose waves dominate fatigue damage, while tail waves still contribute about 14–23%. The fatigue life is also strongly influenced by train operating speeds and train type distribution, highlighting the importance of considering realistic train operating conditions in fatigue assessment and design. The proposed framework provides a practical and scalable tool for fatigue assessment and lifecycle maintenance planning of railway noise barrier systems.

Network-Level Uncertainty-Aware Deterioration Onset Model for Concrete Railway Bridges on Sweden's Iron Ore Line

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Sweden's Iron Ore Line transports over 30 million tons of iron ore annually and depends on a corridor of ageing concrete railway bridges exposed to heavy axle loads and severe climate. Sparse and stepwise inspections make it difficult to identify deterioration consistently and prioritize intervention across the bridge stock. This paper presents a family-based, uncertainty-aware deterioration onset framework for concrete railway bridges on the line. Superstructure and substructure behavior are modelled separately using family-specific time origins, allowing onset to be analyzed in a more physically meaningful way than bridge-level aggregation. Inspection records are transformed into interval-based bridge-family histories while preserving the distinction between observed states and assumed-no-report states. Deterioration onset is defined as the first transition from Good (TK0) to Fair or worse (TK1+) and is analyzed using family-based survival methods with uncertainty propagated through 300 Monte Carlo reruns sampling onset timing, censoring windows, and engineering input variation. For the primary superstructure family, an exploratory Cox proportional-hazards model links onset timing to load-capacity margin and remaining fatigue life, though the association is directional only given the sample size. The results show substantially earlier onset in the two superstructure families than in the substructure family, indicating that the current reinforced-concrete superstructure generation has entered its main onset window while the supporting structure remains on a slower onset trajectory. The study should be read as a corridor-scale proof-of-concept for sparse bridge archives and as an onset-oriented screening tool rather than a full multistate deterioration or failure model.

Self-sensing functionalisation of UHPC

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Ultra-high performance (fiber-reinforced) concrete (UHPC) has been well established as a cementitious composite material with exceptional mechanical properties, durability, and self-healing attributes, both for new construction and retrofitting applications. The integration of self-sensing functionalities into UHPC could further unlock real-time structural health monitoring and timely intervention in critical infrastructure, alleviating complexities and costs arising from existing monitoring systems. However, the scientific literature about the smart functionalization of UHPC is still in its infancy, especially when more sustainable formulations are employed.

This paper investigates separately and synergistically the effect of carbon nanotubes and recycled carbon fibers on the self-sensing performance of sustainable UHPC. The main binder consisted of CEM IV and pozzolan, and the reference mix comprised 2 % vol. of steel fibers. Recycled carbon fibers and carbon nanotubes were incorporated at 0.25 % vol. and 0.1 % wt. binder, respectively. Mechanical characterization tests were performed at 28 days and the self-sensing performance was assessed through cyclic compression tests up to serviceability stress levels with concurrent measurements of electrical resistance. The results enable a direct comparison of the composites with respect to their sensing ability and mechanical performance and highlight the potential of hybrid UHPC formulations in smart applications.

2:00pm - 4:00pm

MS07-2: Distributed fiber optic strain sensing for bridge structural health monitoring

Location: **POT 151**
Session Chair: **Bertram Richter**
Session Chair: **Steffen Marx**

Quality indicators for monitoring data: Adaption for Distributed Fiber Optic Strain Sensing

Ulbrich, Lisa[1]; Richter, Bertram[2]; Walker, Maria[2]; Kroschel, Miriam[2]; Jesse, Frank[1]; Marx, Steffen[2]

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Prestressing wire damage detection with surface distributed fiber optic strain sensing

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Automated crack detection and strain mapping of reinforced concrete structures using 2D-FOS

Becks, Henrik[1,2]; Wellmann, Till[1]; Linden, Christian[1]; Classen, Martin[1,2]
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Characterization of FRP bar bond behavior on an RC tie using DIC and DFOS

Wendler, Tobias; Ruppert, Felix; Plößer, Maurice; Kaiser, Maximilian; de Sousa, Christoph; Grzesiak, Szymon; Pahn, Matthias
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Smart_tendon – Monitoring the post-tensioning process with distributed fiber optic sensors

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Fresh-in-fresh fiber optic sensor embedding for monitoring yarn behavior in carbon-fiber-reinforced concrete: a feasibility study

Ragab, Aya[1]; Janiak, Till[2]; Zierul, Lore[3]; Heins, Kira[4]; Beckmann, Birgit[3]; Adam, Viviane[1]
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φ-OTDR for vehicle detection and traffic monitoring

Rossi, Leonardo[1]; Cheng, Lun-Kai[2]; de Jong, Wim[2]; Scherino, Lorenzo[2]; Jansen, Rob[2]; Bolognini, Gabriele[1]
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Fiber optic shape sensing in the presence of core breakage

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2:00pm - 4:00pm

MS11: Monitoring of corrosion relevant parameters

Location: **BEY E17**
Session Chair: **Rebecca Achenbach**
Session Chair: **Sylvia Keßler**
Session Chair: **Jörg Harnisch**

Novel monitoring solution of all corrosion-relevant parameters for predictive maintenance

Segui Femenias, Yurena; van Ede, Meeke; Honegger, Géorgia
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Influence of cathodic polarization on the chloride threshold for carbon steel in concrete

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Electrochemical characteristics of reinforcement steel in contact with novel binder types

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Geometric effects in Wenner resistivity measurements: methods to determine form factors for concrete specimens

Reichling, Kenji[1]; Harnisch, Jörg[2]; Fache, Konstantin[2]
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Corrosion monitoring to verify the applicability of the W-CL repair principle

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Chloride ion ingress monitoring via self-sensing CNT-coated fiber-reinforced concretes

Bashiri Rezaie, Ali[1]; Liebscher, Marco[1,2]; Mohammadi, Mahsa[1]; Shaikh Ahmad, Mahmoud[1]; Mechtcherine, Viktor[1,2]
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NDT for the in situ assessment of external tendons

Heldt, Kilian[1]; Hornbostel, Karla[2,3]; Osmolska, Magdalena[3]; Dethof, Fabian[1]; Takriti, Ahmad[1]; Alexander, Christopher[4]; Sagüés, Alberto[4]; Keßler, Sylvia[1]
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Condition monitoring and sensor concepts for assessing the technical service life of structural components in interim storage facilities for high-level radioactive waste

Leusmann, Thorsten[1]; von Wehren, Stephan[1]; Matschei, Thomas[1]; Sperbeck, Silvio[2]; Oeff, Julius[3]; Niederleithinger, Ernst[3]
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2:00pm - 4:00pm

MS15: Data-driven monitoring, modelling and assessment strategies for resilient infrastructure

Location: **BEY 117**
Session Chair: **Mohammad Shamim Miah**
Session Chair: **Subhra Majhi**
Session Chair: **Humera Mughal**

Parameter effects in stochastic subspace identification: a quality assurance framework

Nichani, Kapil[1]; Uhlig, Steffen[2]; Colson, Bertrand[1]; Hettwer, Karina[1]; Beering, Carina[2]; Knoth, Sven[2]
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Time-series models performance comparison: feed-forward neural network and autoregressive

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A framework for load estimation for offshore wind turbines based on Kalman filtering and finite-element models

Jensen, Anders Malund Dammark; Thing, Mathias Vedel; Abbiati, Giuseppe
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Predicting crest displacement at Ridracoli dam using non-co-located temperature data

Ullah, Asad[1]; Pereira, Sérgio[2]; Cavalagli, Nicola[1]; Salciarini, Diana[1]; Manciola, Piergiorgio[1]; Buffi, Giulia[3]; Ubertini, Filippo[1]
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Ontology-based modeling of crack width evolution in concrete components

Song, Xiaoli[1]; Peng, Mengyan[1]; Marx, Steffen[1,2]; Kang, Chongjie[1,2]
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Assessing ballast load distribution effects on axle detection in railway B-WIM

Barbély, László; Joó, Attila László
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Enhanced ultrasonic imaging of curved concrete structures using cascading filters

Majhi, Subhra[1]; Acevedo Osma, Juan[2]; Saberpour, Maryam[1]; Mukherjee, Abhijit[1]
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Functionalized carbon fiber textile reinforcements with fiber-based strain sensing

Le Xuan, Hung[1,2]; Happel, Anna[1]; Penzel, Paul[1,2]; Cherif, Chokri[1,2]
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2:00pm - 4:00pm

MS17: Distributed fiber optical sensing (DFOS) in structural engineering research

Location: **BEY 127**
Session Chair: **Yasmin Lemcherreq**
Session Chair: **Christoph Czaderski**

Benefits and challenges of DFOS in reinforced, prestressed and 3D-printed concrete research

Howiacki, Tomasz[1]; Badura, Kamil[2]; Sieńko, Rafał[1]; Bednarski, Łukasz[3]
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Fiber-optic monitoring of shrinkage eigenstrains and gravity behavior in concrete

Esfandiari, Soheil; Raeisi Oskouei, Seyedmorteza; Scholzen, Alexander; Chudoba, Rostislav
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Experimental study of concrete tension members reinforced with BFRP-bars with integrated DFOS

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Experimental investigation of FRP-concrete bond behavior by global and DFOS-based local analysis

Kaiser, Maximilian; Wendler, Tobias; Grzesiak, Szymon; de Sousa, Christoph; Pahn, Matthias
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Information gain of distributed fiber optic sensors for concrete bridge monitoring

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TRM strengthening of masonry panels with integrated optical fiber monitoring: a preliminary study

Rampini, Marco Carlo[1]; Sellitto, Eduardo[1]; Chiadini, Francesco[2]; Ferro, Matteo[3]; Pepe, Marco[1]; Sommella, Paolo[2]; Martinelli, Enzo[1]
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Bond stresses in RC tension chords with multiple rebars – influence of concrete cover

Sørensen, Jesper Harrild; Hoang, Linh Cao
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Preliminary study on crack monitoring in FRCM strengthening equipped with DFOS

Rampini, Marco Carlo[1]; Saidi, Mohamed[2]; Cazzulani, Gabriele[3]; Gabor, Aron[4]
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2:00pm - 4:00pm

MS22-2: Advances in fiber optic sensing solutions for infrastructure, geotechnics, and earth sciences

Location: **BEY 245**
Session Chair: **Massimo Facchini**
Session Chair: **Luca Schenato**
Session Chair: **Lorenzo Brezzi**

EDF's feedback on the operation of fibre optic monitoring systems for hydraulic structures

Courivaud, Jean-Robert[1]; Buchoud, Edouard[1]; Guidoux, Cyril[2]; Hénault, Jean-Marie[1]
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Distributed fiber-optic temperature monitoring and PCA–ICA analysis for near-real-time seepage detection in river levees

Fabbian, Nicola[1]; Ganta, Bogdan[2]; Brezzi, Lorenzo[1]; Cola, Simonetta[1]
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DOFS for an integrated landslide monitoring setup during tunnel excavation

Damiano, Emilia[1]; Alfieri, Mara[2]; de Cristofaro, Martina[1]; Ferlisi, Settimio[2,3]; Guida, Domenico[2,3]; Molitierno, Erika[1]; Valiante, Mario[2]; Olivares, Lucio[1]
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Experimental investigation of debris flow monitoring using DAS in a large-scale physical model

Zampato, Silvia[1]; Poursalimi, Nora[2]; Yujiao, Li[1,4]; Sarno, Luca[2]; Tecca, Pia Rosella[3]; Mandaglio, Maria Clorinda[2]; Marcato, Gianluca[3]; Guarnaccia, Claudio[2]; Rossi, Domenico[2]; Palmieri, Luca[1]; Schenato, Luca[1]; Viccione, Giacomo[2]; Pasuto, Alessandro[3]; Galtarossa, Andrea[1]
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Integrating economic and innovation aspects for improved landslide risk mitigation

Damiano, Emilia[1]; De Cristofaro, Martina[1,3]; Netti, Nadia[2,3]; Olivares, Lucio[1,3]; Olivares, Mattia[3]
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Distributed fiber-optic sensing and 3D laser scanning in an underground mine towards development of a digital twin

Martin, Michael Dieter[1]; Nöther, Nils[2]; Farys, Erik[3]; Facchini, Massimo[2]; Paffenholz, Jens-André[1]
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From DFOS measurements to engineering insights – the role of custom software solutions

Świderski, Mateusz[1]; Dudziński, Patryk[1]; Bocheńska, Marta[1,2]; Gołdyn, Michał[1]; Zdanowicz, Katarzyna[1]
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Fiber optic strain sensing of a solar PV single-axis tracking system under wind loads

Li, You-Jia {Allen}[1]; Zhang, Hanshu[2]; DeJong, Matthew[1]; Chutani, Ayush[3]; Dice, Paul[3]; Dyreson, Ana[3]; Robinson, Gerald[4]
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2:00pm - 4:00pm

MS24-2: Non-destructive testing and monitoring of timber structures

Location: **POT 51**
Session Chair: **Cristoforo Demartino**
Session Chair: **Michele Mirra**
Session Chair: **Vittoria Borghese**
Session Chair: **Angelo Aloisio**
Session Chair: **Martina Sciomenta**
Session Chair: **Antonio Sandoli**
7th Session Chair: Riggio, Mariapaola / Oregon State University, US

Pre-grading of structural timber boards by means of non-destructive dynamic testing

Concu, Giovanna[1]; Giaccu, Gian Felice[2]; Meloni, Daniel[1]; Stochino, Flavio[1]; Valdes, Monica[1]; Zucca, Marco[1]
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Non-destructive field tests and FEA modeling of a timber wharf building in Norway from 1767

Tulebekova, Saule[1,2]; Ostapska, Katarzyna[1]; Conta, Simone[1]
1: SINTEF, Norway; 2: Department of Architecture and Technology, NTNU, Norway; saule.tulebekova@sintef.no

Structural assessment of a decade-old severely degraded glulam roof

Mirra, Michele[1]; Sciomenta, Martina[2]; Rosone, Gloria[2]; Ranalli, Danilo[2]
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Non-destructive evaluation of the elastic properties of CLT floors by vibration techniques

Opazo-Vega, Alexander[1,2]; Araneda, Marcelo[1]; Jara-Cisterna, Alan[1]
1: University of Bío-Bío, Chile; 2: Centro Nacional de Excelencia para la Industria de la Madera (CENAMAD); aopazove@ubiobio.cl

Bayesian vibration-based identification of CLT mechanical properties and connection stiffness

Jara-Cisterna, Alan[1,2,3]; Benedetti, Franco[2,3]; Málaga-Chuquitaype, Christian[4]; Opazo-Vega, Alexander[2,3]
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Microwave measurements – methods for non-destructive condition assessment of timber structures

Loeffler, Julian[1]; Arndt, Ralf[1]; Bonitz, Frank[2]
1: University of Applied Sciences Erfurt, Germany; 2: MFPA Weimar, Germany; frank.bonitz@mfpa.de

Climate monitoring of roof structures with punched metal plate fasteners

Wilden, Vera[1]; Scherer, Jochen[2]; Hoffmeister, Benno[1]
1: RWTH Aachen University, 52074 Aachen, Germany; 2: MiTek Industries GmbH, 51063 Cologne, Germany; v.wilden@stb.rwth-aachen.de

Monitoring of curved long-span timber structures through satellite interferometry

Scoccola, Sandropio; Sandoli, Antonio
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2:00pm - 4:00pm

MS30-2: Video-based and imaging techniques for structural monitoring

Location: **BEY 138**
Session Chair: **Ivan Roselli**
Session Chair: **Stefano De Santis**
Session Chair: **Marialuigia Sangirardi**
Session Chair: **Alessandro Zona**

Using in-situ computer tomography for crack development inside carbon-reinforced hollow core beams – comparison with DIC

Zierul, Lore[1]; Grzesiak, Szymon[2]; Liebold, Frank[3]; Ragab, Aya[4]; Pahn, Matthias[2]; Maas, Hans-Gerd[3]; Adam, Viviane[4]; Beckmann, Birgit[1]
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AI-based RC infilled frame cracks analysis by 3D motion capture displacements in shake table tests

Roselli, Ivan[1]; Palumbo, Domenico[1]; Ormando, Chiara[1]; Colucci, Alessandro[1]; de Felice,

Gianmarco[2]; Nikolic, Milena[2]; De Santis, Stefano[2]; Iovinella, Ivano[1]; Marzo, Anna[1]; Saitta, Fernando[1]; Tripepi, Concetta[1]
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Multitemporal and multimodal SHM for targeted tunnel inspection

Pfeiffer, Jan[1,2]; Mett, Michael[1]; Steiner, Peter[1]; Eder, Simon[1]; Kontrus, Heiner[1]; Paar, Gerhard[3]; Bauer, Arnold[3]; Vierhub-Lorenz, Valentin[4]; Haslgrübler, Michael[5]; Grunicke, Urs[6]
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Integrated 360-degree imaging and digital forms: complementing dam visual inspections

Conde Silva, João; Serra, Carlos; Fernandes, Hugo; Ferreira, Diogo
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Distance-based fire risk classification on construction sites with Unreal Engine simulation validation

Ann, Hojune[1]; Hwang, Dongkyu[1]; Kang, Gi-Sang[1]; Lee, Jong-Jae[1,2]
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4:00pm - 4:30pm

Coffee break
Location: **Exhibition and Catering Rooms: BEY E39, E26, 126**

4:30pm - 6:00pm

Closing ceremony
Location: **POT 81**
Session Chair: **Yvonne Ciupack**
Session Chair: **Steffen Marx**