CCC 2024
Final Programme
Abstracts

14th Central European Congress on Concrete Engineering
14. Středoevropský betonářský kongres

MIKULOV 2024

CCC MEMBER COUNTRIES

Concrete structures – design, construction and rehabilitation in the transition period

Final Programme
Abstracts

Host CCC Association
Czech Concrete Society
Česká betonářská společnost ČSSI
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MIKULOV 2024
September 22 – 24, 2024
Hotel Galant, Mikulov
Czech Republic

Congress website
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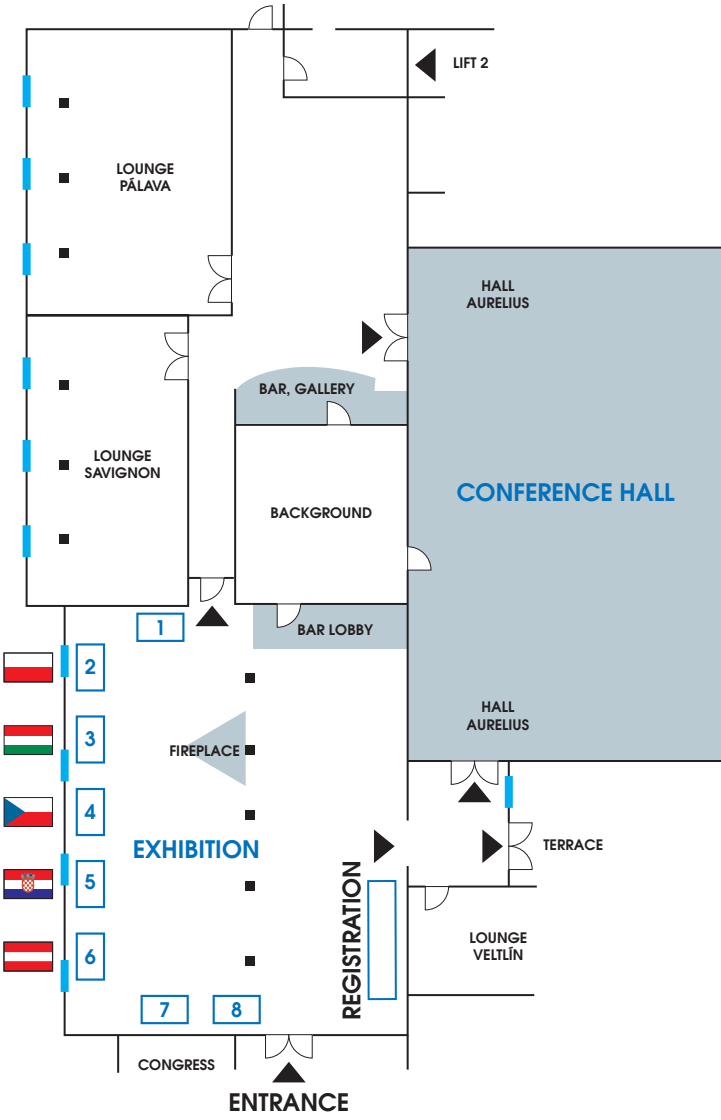
CONGRESS PROGRAMME AT A GLANCE

MONDAY, 23 SEPTEMBER 2024		
08:00–09:00	Registration	
09:00–09:15	**OPENING**	EXHIBITION + POSTER SECTION
09:15–10:45	SESSION 1 **NATIONAL LECTURES**	
10:45–11:15	Coffee break	
11:15–12:45	SESSION 2 **BRIDGES**	
12:45–13:45	Lunch break	
14:00–15:45	SESSION 3 **STRUCTURES**	
15:45–16:15	Coffee break	
16:15–18:15	SESSION 4 **DESIGN AND MODELLING**	
18:15	End of the session	
19:30	**SOCIAL EVENING**	

TUESDAY, 24 SEPTEMBER 2024		
09:00–11:00	SESSION 5 **MONITORING**	EXHIBITION + POSTER SECTION
11:00–11:30	Coffee break	
11:30–13:30	SESSION 6 **TECHNOLOGY**	
13:30–13:45	**CLOSING**	
13:45–14:45	Lunch	

PLAN OF THE CONGRESS AREA AND EXHIBITION



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CONGRESS PROGRAMME

MONDAY, 23 SEPTEMBER 2024

9:00 – 9:15	**OPENING**

9:15 – 10:45	**SESSION 1 NATIONAL LECTURES**
	Temperature criteria for hardening-induced crack control under summer conditions **Dirk Schlicke** (Austria)
	Challenges in 3D concrete printing **György L. Balázs**, Marwah M. Thajeel, Balázs Burai, Ameen H. Chalawi, Rita Nemes, Anna Szijártó, Szögi Tamás, Viktor Hlavicka, András Biró, Kopecskó Katalin, Kapitány Kristof, Éva Lublóy, Salem Nehme, Sándor Sólyom (Hungary)
	Decarbonization of concrete structures from a structural engineer's perspective **Wit Derkowski** (Poland)
	Post-tensioned slabs in garages– A Rational Choice **Josip Galic**, Predrag Presecki, Vlaho Miljanovic (Croatia)
	Development of the conceptual design of bridges **Jan L. Vítek** (Czech Republic)
	Discussion

10:45 – 11:15	Coffee break

11:15 – 12:45	**SESSION 2 BRIDGES**
	Footbridge over the Bečva river, Czech Republic **Pavel Sliwka**, Pavel Kaláb, Jiří Stráský (Czech Republic)
	Viaduct Kriváň – Mýtna on expressway R2, Slovakia Part 1 **Jiří Stráský** (Czech Republic)
	Viaduct Kriváň – Mýtna on expressway R2, Slovakia Part 2 **Libor Hrdina**, Petr Novotný, Petr Kocourek , Jakub Pecha, Daniel Hibš, Jiří Fixel, Jan Nováček, Jiří Stráský (Czech Republic)
	The first reinforced concrete bridges built (up to 1895) in the current area of Poland **Jan Biliszczuk**, Marcin Gniech, Marco Teichgraeber (Poland)
	Footbridge over Railway Station in Cheb, Czech Republic **Jan Nováček**, Pavel Kolenčík, Jiří Stráský, Jiří Urban (Czech Republic)
	Discussion

12:45 – 13:45	Lunch break

CONGRESS PROGRAMME

MONDAY, 23 SEPTEMBER 2024

13:45 – 15:45	SESSION 3 STRUCTURES
	The past decade of UHPFRC bridges in the Czech Republic **Jan Marek**, Jan Prchal, Jiří Kolísko, David Čítek, Petr Tej, Lukáš Vráblík (Czech Republic)
	Innovation and modernization of Gabčíkovo lock chambers **Miloš Zich**, Michael Trnka, Ondřej Šimek, Stanislav Skalník (Czech Republic)
	Obstacles in the design of the new main sewage tunnel in Al Wakrah & Al Wukair **Stephan Kalix**, Peter O'Brien (Austria)
	Investigation on applying TBM thrust load to precast tunnel segments made of FRC **Efim Griniov**, Michael Huß and Dirk Schlicke (Austria)
	Design and detailing of durable and sustainable Post-Tensioning structures with polymer ducts according to fib bulletin 75 **Klaus Lanzinger** and Larry Krauser (USA)
	Building information modelling of bridge and civil engineering s tructures **Paweł Hawryszków**, Marta Knawa-Hawryszków (Poland)
	Execution of repair works on the Trogir – Čiovo Island bridge **Kelava Ante**, Mlinar Ante , Pavić Ljubo, Buzov Ante (Croatia)
	Discussion

15:45 – 16:15	Coffeebreak

CONGRESS PROGRAMME

MONDAY, 23 SEPTEMBER 2024

16:15 – 18:15	SESSION 4 DESIGN AND MODELLING
	Probabilistic Model for Thermal Actions on Concrete Bridges Based on Meteorological Measurements – Case Study **Miroslav Sýkora**, Milan Holý, Jana Marková, Aleš Mezera, Adam Valík (Czech Republic)
	Design of prestressing tendons in statically indeterminate structures using neural network and genetic algorithm **Marcin Jasiński**, Marek Salamak (Poland)
	Influence of beam and aggregate size on the shear capacity of RC beams without shear reinforcement **István Sajtos**, Péter Pál Ther, Rita Vajk (Hungary)
	Pushover analysis of a reinforced concrete two-bay frame: concentrated vs distributed plasticity model **Davor Grandić**, Paulo Šćulac, Dorian Brnić, Martina Višnjić (Croatia)
	Realistic regard of differential settlements in the design of foundation slabs by using non-linear soil material models **Christian Wallner**, Dirk Schlicke, Franz Tschuchnigg (Austria)
	Experimental Verification of Punching Shear with FRP Reinforcement: Innovations in the New Eurocode Generation **David Vašátko**, Kateřina Mrkvová František Girgle, Vojtěch Kostiha, Petr Štěpánek (Czech Republic)
	Numerical studies on the local phenomena in the behaviour of demountable shear connections **Krisztián Király**, Levente Borsi, Nauzika Kovács, László Dunai (Hungary)
	Discussion

18:15	End of the session

19:30	SOCIAL EVENING

CONGRESS PROGRAMME

TUESDAY, 24 SEPTEMBER 2024

9:00 – 11:00	SESSION 5 MONITORING
	Application of Embedded Distributed Fiber Optic Sensors on a Highway Bridge as a Support for Bridge Inspections **Vazul Boros**, Alois Vorwagner, Werner Lienhart, Dominik Prammer (Austria)
	Optical sensors to measure carbonation and chloride ingress in concrete **Isabel Galan**, Marlene Sakoparnig, Isabella Klimczyk, Bernhard Müller, Leonard Sterz, Cyrill Grengg, Florian Mittermayr, Joachim Juhart, Torsten Mayr (Austria)
	Assessment of the viaduct over the Sava-Odra flood control canal **Gordana Hrelja Kovačević**, Nijaz Mujkanović, Mladen Srbić, Anđelko Vlašić (Croatia)
	Damage on Concrete Bridges Due to Projectile Impact and Blast Loading **Marija Kušter Marić**, Ivana Mijadžiković , Mladen Fusić, Mladen Srbić and Vladimir Horvat (Croatia)
	Measurement of the shear lag effect in BFRP bars using DIC **Szabolcs Szinvai**, Tamás Kovács (Hungary)
	Smart Health Monitoring of Concrete Bridges using Digital Twin and AI Applications **Asseel Al-Hijazeen**, Kálmán Koris (Hungary)
	The Sweating Slab Syndrome – A Scientific Analysis **Manfred Kehrer**, Todd Nelson, (USA)
	Discussion

11:00 – 11:30	Coffeebreak

CONGRESS PROGRAMME

TUESDAY, 24 SEPTEMBER 2024

11:30 – 13:30	SESSION 6 TECHNOLOGY
	Experimental study of FRP reinforced LWC beams **Balint Somlai**, Sandor Solyom (Hungary)
	Determination of the Deformation Behavior of Concrete Structures Reinforced with FRP Bars: A theoretical study **Kateřina Mrkvová**, David Vašátko , František Girgle, Petr Štěpánek (Czech Republic)
	The use of concrete with significantly reduced cement content in winter conditions **Pavel Kasal**, Michael Härtel, Daniela Ehrenreich (Austria)
	The Stiffness Analysis of Lightweight Concrete Deck Slabs with GFRP Reinforcement under Fatigue Loading Conditions **Agnieszka Wiater**, Tomasz Siwowski (Poland)
	Experimental investigations of effects of traffic-induced vibrations on young concrete **Christian Gasser**, Alois Vorwagner, Stefanie Klackl, Tanja Manninger (Austria)
	Finite element modelling for 3D concrete printing framework and examples **Jan Červenka**, Jiří Rymeš, Libor Jendele (Czech Republic)
	Durability of dry basalt yarns in different alkaline environments **Delara Etezad**, Leonhard Randl , Agathe Robisson, Teresa Liberto, Philipp Preinstorfer (Austria)
	Discussion

13:30 – 13:45	CLOSING

13:45 – 14:45	Lunch

POSTERS

P1	**Investigating the Durability of Concrete Reinforced with Waste Tire Steel Fibers** **Asad Zia**, Ivan Hollý, Jaroslav Prokop (Slovakia)
P2	**Creep and shrinkage measured on different concretes for bridges** **Vít Němčic**, Jan L. Vítek (Czech Republic)
P3	**Model Uncertainty in European UHPC Standards: Insights from SIA2052 and NF P18-710 Flexure Models** **Lenganji Simwanda1** , Miroslav Sýkora, Jana Marková (Czech Republic)
P4	**The effect of the use of recycled concrete aggregates on the properties of hardened concrete** **Adrián Ondák**, Ivan Hollý, Jaroslav Prokop (Slovakia)
P5	**Minimum reinforcement against brittle failure in concrete structures** **Marta Słowik** , Izabela Skrzypczak (Poland)
P6	**Properties of Fibers and Mortar of Slurry Infiltrated Fiber Concrete (SIFCON)** **Wisam K. Tuama**, György L. Balázs (Hugary)
P7	**Compressive behavior of a hybrid steel-concrete joint for discrete reticulated timber structures** **Žiga Unuk** (Slovenia)
P8	**Proposal of a health monitoring system on the RC bridge with confirmed degradation** **Muhammad Fawad**, Kalman Koris , Marek Salamak, Dawid Piotrowski, Marcin Jasinski (Poland)
P9	**Preliminary results for physical properties of concrete based on variable aggregates particle distribution curve** **Peter Czirak**, Martin Palou, Jana Čepčianska (Slovakia)
P10	**Bridge Modelling and Structural Analysis in BIM** **Jelena Bleiziffer**, Marta Miloš (Croatia)

ABSTRACTS

MONDAY, 23 SEPTEMBER 2024

SESSION 1 9:15–10:45

TEMPERATURE CRITERIA FOR HARDENING-INDUCED CRACK CONTROL UNDER SUMMER CONDITIONS

Dirk Schlicke

Concrete casting under summer conditions is a serious matter. On the one hand, increased fresh concrete temperatures affect the workability of the fresh concrete; on the other hand, the hydration may take place in summer on a higher temperature level and if the absolute member temperatures increase therefore noticeably during hydration it may affect strength evolution and mineral stability of the concrete. The literature therefore contains specific recommendations for concreting under summer conditions. In these recommendations, the fresh concrete temperature and evaporation on the free surfaces are primarily limited in order to ensure workability even at higher ambient temperatures. Regarding mineral stability it is rather generally regulated to keep the absolute concrete temperature well below 70 °C.
A different situation exists if temperature limits are specified in order to keep the hardening-related cracking due to the heat of hydration within a tolerable range or even to exclude it altogether. These temperature limits are usually specified on basis of absolute values and independently of the seasonal boundary conditions.
In high summer, however, the latter temperature criteria can often no longer be met at a reasonable cost or even require measures that put risk at the quality of the concrete member in other ways. On the basis of on-site monitoring and extensive thermomechanical simulations, this contribution discusses the usefulness of absolute and independently of the seasonal boundary conditions determined temperature limits for controlling hardening-induced cracking under summer conditions.

SESSION 1 9:15–10:45

CHALLENGES IN 3D CONCRETE PRINTING

György L. Balázs, Marwah M. Thajeel, Balázs Burai, Ameen H. Chalawi, Rita Nemes, Anna Szijártó, Szögi Tamás, Viktor Hlavicka, András Biró, Kopecskó Katalin, Kapitány Kristof, Éva Lublóy, Salem Nehme, Sándor Sólyom

The 3D Concrete Printing offers a new technology with many challenges. On the other hand, it offers the collaboration of different parts of engineering: civil engineers, architects, mechanical and electric engineers. Recently we were able to establish a framework for 3D Concrete Printing,

based on a Hungarian Research Grant VKE 2018-1-3-1_0003 "Development of advanced concrete elements based on new results of materials' science". The equipment include a robot, a concrete mixer and a control panel to supervise the printing processes. We selected a robot type printing system in order to be able to follow every printing steps in details. Our contribution would like to give an overview of the initial part of our activities in 3D Concrete Printing for the CCC2024 Congress.

SESSION 1 9:15–10:45

DECARBONIZATION OF CONCRETE STRUCTURES FROM A STRUCTURAL ENGINEER'S PERSPECTIVE

Wit Derkowski

It is increasingly evident that the construction industry must undergo a thorough transformation. Globally, the construction sector is responsible for up to 50% of carbon emissions and approximately 50% of resource consumption. This high resource consumption correlates with substantial waste generation. To reduce the environmental impact of civil engineering, priority should be given to preserving existing structures, even if they require repair or significant retrofitting, or at least reusing their components.. However, practical implementation is challenging, primarily due to the lack of proper assessment of existing structures, which is crucial for making decisions regarding liability. Currently, there are no well-established rules for determining the design life and safety of structures incorporating elements derived from dismantled ones. This paper identifies, based on the report prepared for the European Commission [1], best practices in the construction industry and the most promising measures to reduce its climate impact in the future. From the structural engineer's perspective, these measures would certainly involve substituting carbon-intensive materials with low-carbon alternatives and embracing adaptive, modular, and reversible designs supported by data-driven models. Reuse and disassembly are crucial for circular systems in the construction industry, particularly in designing connections and ensuring the transfer of information about structural elements throughout their lifecycle, including the concept of creating 'smart elements' equipped with Structural Health Monitoring (SHM) systems. The possibilities for implementing the concept of reuse of building structures is also discussed in the paper.

ABSTRACTS

SESSION 1 9:15–10:45

POST-TENSIONED SLABS IN GARAGES – A RATIONAL CHOICE

Josip Galic, Predrag Presecki, Vlaho Miljanovic

The paper analyzes 3 different concepts of ceiling slabs for garages with regard to the usual spacing of columns (8 × 8 m; 5 × 11.2 m and 5 × 16.2 m). A comparison of reinforced and post-tensioned concrete slabs is given. The advantages of post-tensioned panels in terms of a larger number of parking spaces and lower consumption of materials (concrete and steel) are presented. Optimization of space and lower consumption of materials are extremely important in modern construction in order to reduce CO_2 emissions and increase the flexibility of space.

SESSION 1 9:15–10:45

DEVELOPMENT OF CONCEPTUAL DESIGN OF BRIDGES

Jan L. Vítek

Bridge design developed for centuries. Bridges were originally designed on the basis of experience, during the time a lot of additional criteria influencing the design have been involved. The primary role of the design is played by the design engineer, who is responsible for the evaluation of conditions in the location, design of the bridge structural system, of structural details and of the construction process. The opinions on the structural system changed with development of the design methods. On the other hand, the advanced numerical tools are not able to replace the creativity of the designer.

SESSION 2 11:15–12:45

FOOTBRIDGE OVER THE BEČVA RIVER, CZECH REPUBLIC

Pavel Sliwka, Pavel Kaláb, Jiří Stráský

The article describes the design and construction of the footbridge, which has been under construction between 2020–2023. The suspension footbridge superstructure consists of precast concrete segments, that are suspended on main cables further anchored at inclined "V"-shaped concrete pylons. The main span length is 105,0 m, the overall length approx. 145,0 m and the segment width 5,25 m.

ABSTRACTS

SESSION 2 11:15–12:45

VIADUCT KRIVÁŇ – MÝTNA ON EXPRESSWAY R2, SLOVAKIA

Libor Hrdina, Petr Novotný, Petr Kocourek , Jakub Pecha, Daniel Hibš, Jiří Fixel, Jan Nováček, Jiří Stráský

On the construction site R2 Kriváň – Mýtna, a continuous bridge of the total length of 4.5 km is being realized and formed of 8 dilatation units (DC). The first 6 units are conceptually identical and are built using movable scaffolding system and balanced cantilever method. Superstructures are formed by a spine box girder from prestressed concrete with large transverse overhangs supported by precast struts. The span lengths are variable from 60 to 70 m for DC using movable scaffolding with constant cross-section height of 3.50 m, for balanced cantilever method the span lengths are variable between 100.0 – 150.0 m and the cross-section height is variable from 3.50 m in the middle of the span up to 9.0 m above the support. Piers are either integrated with the superstructures or articulated using concrete hinges, exceptionally by bearings. Parts DC3 and DC4 of the bridge object 209-02 are being constructed by the method of incremental launching. The superstructure is formed by a single box girder with large overhangs supported by precast bar struts. Spans are 48.75+5×60.0+48.75m, the width of the deck is 26.7m, the height is 3.5m and the box width is 6.5m. The deck in its full width is being incrementally launched by 30 to 35m-long segments. In the service stage, the deck will be connected to the substructure by means of concrete hinges, exceptionally by bearings.

SESSION 2 11:15–12:45

THE FIRST REINFORCED CONCRETE BRIDGES BUILT (UP TO 1895) IN THE CURRENT AREA OF POLAND

Jan Biliszczuk, Marcin Gniech, Marco Teichgraeber

This article delves into the significant history of the oldest reinforced concrete bridges in present-day Poland. These bridges serve as prime examples, illustrating the innovative idea and methodology of concreting technology, as introduced by Monier, a technological novelty that swept across Europe at the end of the 19th century. The article serves as a comprehensive summary of the current historical knowledge in this field, emphasizing the pivotal role of these bridges in the evolution of construction technology.

ABSTRACTS

SESSION 2 11:15–12:45

FOOTBRIDGE OVER RAILWAY STATION IN CHEB, CZECH REPUBLIC

Jan Nováček, Pavel Kolenčík, Jiří Stráský, Jiří Urban

The footbridge is designed as a prestressed concrete structure supplemented by a pair of steel pylons with semi-radial cables supporting the longest span of 87 m. The total length of the structure is 397.1 m with its 10 spans and it crosses 39 tracks in the area of Cheb railway station. The superstructure is produced in the casting yard and the individual segments are incrementally launched over the entire track together with the already installed pylon, which are an integral part of the superstructure.

SESSION 3 13:45–15:45

THE PAST DECADE OF UHPFRC BRIDGES IN THE CZECH REPUBLIC

Jan Marek, Jan Prchal, Jiří Kolísko, David Čítek, Petr Tej, Lukáš Vráblík

This paper presents the overview of substantial UHPFRC structures in the Czech Republic built in last ten years. Number of bridges constructed with precast UHPFRC elements evolved vigorously in the past decade. The knowledge base for the design, production and construction concluded in 2024 in the new Czech standard, TP267.
Brief look into the research and development of this modern composite is given, the development from lab to the construction site is shown on concrete examples. Future vision and projects in preparation are mentioned.

SESSION 3 13:45–15:45

INNOVATION AND MODERNIZATION OF GABČÍKOVO LOCK CHAMBERS

Miloš Zich, Michael Trnka, Ondřej Šimek, Stanislav Skalník

From 2019 to 2023, an extensive innovation and modernization took place at the lock chambers of the Gabčíkovo waterworks to increase the safety and intensity of the water transport. The waterworks is located on the Danube River about 60 km southeast of Bratislava – the capital of Slovakia. There are two lock chambers (left and right) of similar dimensions. Parameter-wise, it is a unique waterworks among the largest navigational locks in the world. The usable length of one chamber is 275 m, width 34 m and with minimum depth 4.5 m. Depending on the flow rate, the lock water gradient ranges from 12.7 m to 23.6 m. The lock consists of the upper block with gate, the six dilatation blocks of the lock chamber (length of each block is 50 m), the lower block with gate, the inlet object, the outlet

object and the system of filling and emptying the channels. The locks have been in operation since 1992. After about thirty years of operation, its modernization and innovation were carried out. The total cost of the modernization is 150 million euros. Last year, the innovation of the right and left lock was completed. The lower gate, the upper gate, the safety flap gate, the regulation valves, the temporary protection dam of channels, floats, etc. were replaced. The paper focuses on the description of the innovated structures and especially on the description of new concrete structures used to ensure the transfer of forces from steel elements (gates) to the original concrete structure.

SESSION 3 13:45–15:45

OBSTACLES IN THE DESIGN OF THE NEW MAIN SEWAGE TUNNEL IN AL WAKRAH & AL WUKAIR

Stephan Kalix, Plamen Nikolov, Peter O'Brien

The Project "Wakrah and Wukair Drainage Tunnel – C853/2" is located in the southern part of Doha in the vicinity of Wakrah and Wukair Municipalities and is part of the sewage networks of these locations. The project comprises the design and construction of a 13.3 km long TBM sewage tunnel in double-shell construction with 4500 mm inner diameter and up to 61 m depth, 8 access shafts and drop structures, which are all part of the Wakrah – Wukair and industrial area sewage network.
VCE's scope covers the structural design of all temporary shafts with an inner diameter of up to 20.5 m and up to 63 m depth, around 300 m of NATM tunnels, the around 13.1 km long segment tunnel, around 300 m of cast in-situ concrete tunnel, the complete tunnel inner lining and all permanent shaft structures. The design is carried out using the method Building Information Modeling (BIM). Furthermore, VCE was also responsible for the hydraulic design, which includes the 1D-hydraulic and CFD-simulations with 3D-models for four complex shaft structures.

SESSION 3 13:45–15:45

INVESTIGATION ON APPLYING TBM THRUST LOAD TO PRECAST TUNNEL SEGMENTS MADE OF FRC

Efim Griniov, Michael Huß, Dirk Schlicke

The process of machine tunneling often involves tunnel boring machines (TBM) using precast concrete segments. These segments are typically reinforced with traditional steel reinforcement. In the Austrian FFG project "FRC tunnel segments" an alternative reinforcement concept of segments consisting only fiber reinforced concrete (FRC) was investigated. This process eliminates the need for conventional steel reinforcement and

ABSTRACTS

increases the resource and construction efficiency. An essential aspect in this regard is the load application by the TBM thrust jacks.
This paper presents a detailed study conducted at the Graz University of Technology by the Institute of Structural Concrete in cooperation with the Austrian Society for Construction Technology (ÖBV) focusing on the structural response of FRC segments under TBM thrust loads. Large-scale tests were carried out to examine the behavior of FRC segments under simulated TBM-induced forces. Furthermore, extensive parameter studies employing nonlinear finite element analysis were conducted to analyze the local force distribution and crack propagation within FRC segments. Based on the findings, a simplified engineering model will be prepared for the design of pure FRC segments. This contribution presents and discusses the mentioned research activities in detail with focus on large-scale tests.

SESSION 3 13:45–15:45

DESIGN AND DETAILING OF DURABLE AND SUSTAINABLE POST-TENSIONING STRUCTURES WITH POLYMER DUCTS ACCORDING TO *FIB* BULLETIN 75

Klaus Lanzinger, Larry Krauser

In order to build durable and sustainable prestressed concrete bridges and structures, preventing the steel components and the tendons from corrosion is key. Accordingly, for bridges with internal bonded post-tensioning, polymer duct systems should be used. The article gives an overview of the 50-years history of plastic ducts in post-tensioning, the selection of tendon protection levels (PL's) according to fib bulletin 33 [1] and information for structural engineers regarding design and detailing of concrete structures with polymer ducts according to fib bulletin 75 [2].

SESSION 3 13:45–15:45

BUILDING INFORMATION MODELLING OF BRIDGE AND CIVIL ENGINEERING S TRUCTURES

Paweł Hawryszków, Marta Knawa-Hawryszków

A modern „Building Information Modelling" – BIM technology will be a topic of a proposed conference paper. The paper will be focused on BIM application in Bridge and Civil Engineering area. The computational examples presented in the paper will be based on structures made of concrete. Results of BIM modelling, together with FEM analyses will be discussed. Examples, presented below, were prepared within and / or as a consequence of the international Erasmus+ project, leaded by several EU countries, in which both authors are involved. The project will be described

together with its achievements, purposes, development of new ideas and training methods.

SESSION 3 13:45–15:45

EXECUTION OF REPAIR WORKS ON THE TROGIR – ČIOVO ISLAND BRIDGE

Kelava Ante, Mlinar Ante, Pavić Ljubo, Buzov Ante

The paper presents the execution of repair works of the movable bridge conducted by Spegra, a company specialized in the restoration and reconstruction of various types of structures. The Trogir – Čiovo Island bridge is located on the Croatian coast near the historic city of Trogir. The bridge spans a narrow sea strait, connecting the city of Trogir with the nearby Čiovo Island. It was built in 1962 as a movable bridge with a structure consisting of steel and reinforced concrete elements with a stone cladding. The bridge has three spans, with a total length of 102 meters including approaches. The central movable span structure is an arch steel construction, while the other two are reinforced concrete arches. The bridge restoration works are divided into three groups. The first group: dismantling, restoration, and assembly of the steel span structure and expansion joint steel elements. The second group: restoration of reinforced concrete elements: roadway slabs, pedestrian walkways, arches, and the interior of caissons. The third group: restoration of the stone cladding of the bridge. All works were conducted in cooperation with the Conservation Department of the city of Trogir.

SESSION 4 16:15–18:15

PROBABILISTIC MODEL FOR THERMAL ACTIONS ON CONCRETE BRIDGES BASED ON METEOROLOGICAL MEASUREMENTS – CASE STUDY

Miroslav Sýkora, Milan Holý, Jana Marková, Aleš Mezera, Adam Valík

Reliability assessments of concrete bridges are currently made using valid codes of practice based on the limit state concept. Verification may be carried out using the partial factor format or structural reliability methods. The reliability assessment should be made taking into account the service life of a structure, the selected reference period, and the changes in the environment of the structure and possibly anticipated changes in use. This contribution focuses on the verification of models for thermal actions for concrete bridges. An example of updating the design value and partial factor for thermal actions using site-specific measurements – shade air temperature measurements and on-bridge measurements – is developed. Two probabilistic models are employed to characterise annual extremes

ABSTRACTS

of ambient air temperatures and the effect of choice of the distribution on the partial factor for thermal actions is discussed. It appears that on-bridge measurements may significantly improve the model for both uniform temperature and temperature difference components in comparison to the EN 1991-1-5 model, with reduction of the design value up to 30% in the case study. A useful alternative for practical applications is to update thermal action effects using records from the nearest meteorological station (reduction about 20%). Using either meteorological or on-bridge measurements, the partial factor can be decreased to 1.2 for the uniform temperature component and to 1.3 for the difference temperature component. The choice of probabilistic distribution seems to be of low importance for the bridge under consideration. Further research should be mainly focused on investigating the effects of climate change and analysis of thermal action effects on different types of concrete bridges and bridges from other structural materials.

SESSION 4 16:15–18:15

DESIGN OF PRESTRESSING TENDONS IN STATICALLY INDETERMINATE STRUCTURES USING NEURAL NETWORK AND GENETIC ALGORITHM

Marcin Jasiński, Marek Salamak

The article presents the possibility of combining a genetic algorithm and a neural network to develop an innovative approach to the design of statically indeterminate prestressed concrete structures. An integral part of this approach is the parametric definition of the tendon geometry, consisting of mutually tangent straight sections and circular arcs. The genetic algorithm was used to minimize the total weight of the prestressing steel and ensure a correct design with no limit state exceedances. Since prestress evaluation in statically indeterminate structures requires repetitive and time-consuming numerical simulations, usually finite element analysis, the neural network was used to predict numerical output based on layout parameters. This research shows the assumptions and implementation of the methods using a two-span, two-girder bridge structure as an example

SESSION 4 16:15–18:15

INFLUENCE OF BEAM AND AGGREGATE SIZE ON THE SHEAR CAPACITY OF RC BEAMS WITHOUT SHEAR REINFORCEMENT

István Sajtos, Péter Pál Ther, Rita Vajk

It is accepted in engineering practice that the nominal shear strength of RC beams depends on the beam size. It is experimental evidence; otherwise,

it is theoretically investigated and proved, e.g., Bazant's size effect law. However, it is a common expectation that reinforced concrete structures have the same load-bearing capacity and failure mode independently of the maximum aggregate size and grading curve of the used aggregates if the strength class of the concrete is the same. It is also well known that many parameters influence the load-bearing capacity of the RC beams without shear reinforcement in very complex ways, e.g., strength of concrete, amount of longitudinal reinforcement, and beam sizes, among others. That is why it is no coincidence that there is no mathematical model or clear and transparent understanding of the shear behavior of RC beams.

Let's ask whether it has any significance or consequences – e.g., from the point of view of load-bearing capacity and mode of failure of reinforced concrete beams – if we change the aggregate size used for concrete but not the strength of concrete (strength class of concrete)!

Based on Bazant's size effect law, the paper will interpret and explain how the aggregate size influences the nominal shear strength of the RC beams without shear reinforcement in interaction with other parameters.

In our analysis and explanation, the fracture energy and the maximum aggregate size, d_{max}, play an important role. The fracture energy changes by d_{max} in conjunction with fracture surface roughness. We demonstrate the effectiveness of the size effect model by comparing the theoretical results to experimental ones. The model also confirms the building practice where a larger maximum aggregate size is used for larger RC structures.

SESSION 4 16:15–18:15

PUSHOVER ANALYSIS OF A REINFORCED CONCRETE TWO-BAY FRAME: CONCENTRATED VS DISTRIBUTED PLASTICITY MODEL

Davor Grandić, Paulo Šćulac, Dorian Brnić, Martina Višnjić

This paper presents results of nonlinear static pushover analyses of a reinforced concrete two-bay frame using two different plasticity models. In the first model concentrated plasticity is applied: columns and beams are modelled by linear elastic elements, while plastic hinges are defined by link elements, in which the bilinear bending moment-rotation relationships are embedded. In the second model distributed plasticity is applied: beams and columns are modelled with inelastic elements. The element cross-section is subdivided into fibers, described with nonlinear uniaxial stress-strain relationships for reinforcing steel and concrete. In both models the effect of concrete confinement due to closely-spaced hoops in the critical region is taken into account. Before nonlinear analyses the frame was designed using capacity design approach according to EN 1998-1:2004. The sequence of formation of plastic hinges is presented and the behaviour of the frame is analyzed. The desired failure mechanism

of the frame during an earthquake, i.e. the strong columns-weak beams concept is verified.

SESSION 4 16:15–18:15

REALISTIC REGARD OF DIFFERENTIAL SETTLEMENTS IN THE DESIGN OF FOUNDATION SLABS BY USING NON-LINEAR SOIL MATERIAL MODELS

Christian Wallner, Dirk Schlicke, Franz Tschuchnigg

Differential settlements affect the internal forces in foundation slabs as imposed deformation. Therefore, the design and the material requirements of foundation slabs depend on this interaction and its consideration. In the structural design phase, however, the highly non-linear behavior of soil is usually considered only linear. Of course, if the linear bedding is derived from a nonlinear soil analysis, it is still adequately regarded in structural design if the load case is the same in both analysis. However, in the regular structural design the soil structure interaction is applied for all load combinations and limit states without adoption to a possible change of the (nonlinear) stiffness distribution in the bedding surface. Particularly, neglecting soil hardening leads to overestimated differential settlements and oversized design. Furthermore, a poor settlement prediction affects not only the foundation elements but may indicate also wrong stress redistribution within the structure. In this work, we evaluate the differential settlements in foundation slabs by using non-linear soil models and compare this with linear model approaches with regard to load combinations and limit states. Altogether, this study focuses on a selected variety of common soil materials and structure geometries to cover a broad field of possible combinations. Regarding to this, recommendations for the soil structure interaction and the calculation of differential settlements are made for common cases.

SESSION 4 16:15–18:15

EXPERIMENTAL VERIFICATION OF PUNCHING SHEAR WITH FRP REINFORCEMENT: INNOVATIONS IN THE NEW EUROCODE GENERATION

David Vašátko, Kateřina Mrkvová, František Girgle, Vojtěch Kostiha, Petr Štěpánek

The new generation of Eurocodes for concrete structures, specifically the draft standard FprEN 1992-1-1:2023, introduces an innovative application of non-prestressed Fibre Reinforced Polymer (FRP) reinforcement

ABSTRACTS

(Annex R). This standard represents the first standardized method for the application of FRP reinforcement, an area that has been lacking in European standards to date. Composite reinforcement using glass (GFRP) or carbon fibre (CFRP) provides a perspective alternative in specific applications where it can replace traditional steel or stainless steel reinforcement. The main advantages are high corrosion resistance and electromagnetic neutrality. This allows for application in structures exposed to a high level of environmental impact. However, composite reinforcement with glass fibres exhibits sensitivity to alkaline environments and has a lower modulus of elasticity compared to steel reinforcement. Due to the linear elastic stress-strain diagram for FRP reinforcement, the design of structures with FRP reinforcement requires a different approach than traditional concrete reinforcement.
The standard FprEN 1992-1-1:2023 provides specific approaches for the design of concrete elements using FRP reinforcement, considering various types of loading. In the context of design resistance to punching shear, the standard offers a specific relationship that determining the punching shear resistance for using longitudinal FRP reinforcement. In situations where it is necessary to consider punching shear reinforcement, the shear reinforcement should not be made from FRP. The transition to the new Eurocode brings significant changes in the method of design punching shear resistance compared to the current standard ČSN EN 1992-1-1. The aim is to verify the accuracy of the newly introduced relationships for punching shear through a real experiment with steel and FRP longitudinal reinforcement. The experiment will also research the effect of the adding FRP stirrups on the overall resistance under local loading conditions.

SESSION 4 16:15–18:15

NUMERICAL STUDIES ON THE LOCAL PHENOMENA IN THE BEHAVIOUR OF DEMOUNTABLE SHEAR CONNECTIONS

Krisztián Király, Levente Borsi, Nauzika Kovács, László Dunai

Sustainable composite structures for building construction are assembled using demountable structural elements and shear connectors that can be reused and fit into the circular economy. The current research and development project, in cooperation with Budapest University of Technology and Economics and KÉSZ Group, bim.GROUP Ltd, Hungary, aims to design an innovative, demountable steel-concrete composite slab system. The proposed structural solution is constructed by steel beams and precast reinforced concrete panels, with embedded bolts and through bolts – as demountable shear connectors – considering the international trends and the company's practice. Steel assemblies and mortar filling in the concrete panels provide better tolerances, decreasing the initial slip and the stiffness reduction of the composite beam, as an unfavourable and critical phenomenon of demountable composite structures. A push-

out experimental program was designed and completed, then extended by numerical studies in the ATENA program to study the behaviour of the developed shear connections. Based on the results, it can be stated that the shear connection has proper behaviour with sufficient stiffness, resistance, and ductility. It is observed that the material properties of the concrete and the mortar filling, as the surrounding region of the shear connector, highly determine the structural behaviour. A numerical model is developed focusing on this detail to study the local behaviour modes. A numerical parametric study was completed with the purpose of improving the behaviour of the shear connector. In the study, the influence and sensitivity of the material properties of the concrete, mortar filling, and shear connector are investigated. In addition, the effects of different tolerances and bolt positions are also considered. In the paper, the summary of the push-out experimental program is presented, and the main observations of the numerical program are concluded.

TUESDAY, 24 SEPTEMBER 2024

SESSION 5 9:00–11:00

APPLICATION OF EMBEDDED DISTRIBUTED FIBER OPTIC SENSORS ON A HIGHWAY BRIDGE AS A SUPPORT FOR BRIDGE INSPECTIONS

Vazul Boros, Alois Vorwagner, Werner Lienhart, Dominik Prammer

In recent years distributed fiber optic sensors (DFOS) have found their way into the structural health monitoring (SHM) of bridges and other civil engineering structures. In contrast to traditional strain gauges and temperature sensors, which enable measurements at predefined points, DFOS allow the continuous monitoring of each point along the optical fiber. This technology therefore offers exceptional benefits for observing the development of cracks in reinforced concrete structures, since their exact location and width is normally not known beforehand.
SHM is mostly considered an expensive method reserved for ageing structures already showing signs of deterioration. The retroactive installation of DFOS on bridges is indeed cumbersome, as the access to the structure requires special equipment and the cables must be installed using adhesives, often in a groove cut in advance. If the cables are embedded in the structure before the pouring of the concrete however, the labor costs drop to a bare minimum. Furthermore, in contrast to the subsequent installation of the DFOS, the measurements can be compared to an initial state during or immediately after construction.
In a research project funded by the Austrian motorway operator ASFiNAG this concept was tested on a 420 m long prestressed concrete bridge. Fiber optic cables were installed for measuring strain and temperature. The cables were scanned at several stages of the construction process

using different types of interrogators. Additionally static and dynamic tests with predefined loads have been carried out, supplemented also by other monitoring techniques such as high precision ESR strain sensors, laser scanning, GNSS sensors, robotic total stations, laser vibrometers or a camera with motion amplification® video processing algorithm. The aim is to validate the concept of supporting regular bridge inspections by data obtained from DFOS measurements. This can provide valuable additional information on the location of cracks and their development over time from the initial state.

SESSION 5 9:00–11:00

OPTICAL SENSORS TO MEASURE CARBONATION AND CHLORIDE INGRESS IN CONCRETE

Isabel Galan, Marlene Sakoparnig, Isabella Klimczyk, Bernhard Müller, Leonard Sterz, Cyrill Grengg, Florian Mittermayr, Joachim Juhart, Torsten Mayr

The application of optical sensors to measure pH and chloride concentration of cement-based materials offers new possibilities for a more accurate assessment of the durability properties.
In this contribution recent advancements are presented: (i) high resolution pH imaging to produce pH-maps of carbonated mortars made from different cements, (ii) point surface measurements to monitor pH evolution during hydration of clinker-reduced mixes, (iii) assessment of stability of optical methods and comparison with pore solution extraction, and (iv) combination of pH and water-soluble Cl profile measurements of carbonated samples containing chloride.
These innovative methodologies allow for a deeper understanding of the processes occurring in cementitious matrices during hydration and exposure to the environment.

SESSION 5 9:00–11:00

ASSESSMENT OF THE VIADUCT OVER THE SAVA-ODRA FLOOD CONTROL CANAL

Gordana Hrelja Kovačević, Nijaz Mujkanović, Mladen Srbić, Anđelko Vlašić

The south-western entrance to the city of Zagreb crosses the Sava-Odra flood control canal. The canal is crossed by two viaducts with 17 spans and a total length of 435 meters. Each viaduct is intended for one traffic direction. The viaduct consists of six dilatations. The structural system of each dilatation is a continuous girder over three spans. The cross-section of the viaduct consists of five prestressed reinforced concrete girders. The girders are supported by bents over two columns, on shallow foundation.

ABSTRACTS

Due to heavy traffic load and many dilatations, previously, there was considerable damage to the superstructure and the substructure elements. Rehabilitation measures have been carried out several times in the past. During the 2020 post-earthquake inspection, significant damage was found on the girders, column bents, columns, and bridge equipment. Considering the current condition and age (it was built in 1972) of the viaduct, extensive investigation, and an assessment of the condition of the bridge for traffic and seismic action was carried out in accordance with current codes and regulations in order to make decisions on future actions. This paper provides a comprehensive assessment of the viaduct's condition and recommendations on how to proceed with rehabilitation/ reconstruction of the viaduct.

SESSION 5 9:00–11:00

DAMAGE ON CONCRETE BRIDGES DUE TO PROJECTILE IMPACT AND BLAST LOADING

Marija Kušter Marić, Ivana Mijadžiković, Mladen Fusić, Mladen Srbić, Vladimir Horvat

During the Homeland War in Croatia (1991–1995), more than 100 bridges are demolished or damaged, of which 70 are concrete bridges. A projectile impact usually only damages the bridge, as it is more difficult to control action, unlike explosives, which can lead to partial or complete collapse of the bridge. Of the 70 analyzed concrete bridges, 60% were demolished (completely or partially), while the other 40% were only damaged. In the case of multi-span bridges that have been blown up with explosives, the chosen locations for placing the explosives are primarily the piers. This is because piers have smaller cross-sectional dimensions compared to the superstructure and abutments and therefore require a smaller amount of explosives to achieve the collapse of the element. This article describes the demolition of two reinforced concrete piers by explosives. One pier was completely demolished, while the concrete of the other column was broken out. Non-destructive tests (ultrasonic velocity, concrete resistivity and compressive strength) were carried out on the piers before and after the explosion in order to compare the measured values and determine the damage caused after the explosion.

SESSION 5 9:00–11:00

MEASUREMENT OF THE SHEAR LAG EFFECT IN BFRP BARS USING DIC

Szabolcs Szinvai, Dr. Tamás Kovács

The corrosion resistance of fiber reinforced polymer (FRP) bars makes them a valid alternative to steel bars. The most important material properties

of a bar are the modulus of elasticity and the tensile strength. To measure these values, tensile tests are necessary.
Thus, tensile tests were performed on basalt FRP bars with 8 and 12 mm diameter. Due to the low mechanical properties of the matrix material, shear deformations will occur during tension, making the stress distribution between the fibers uneven, which is called the shear lag effect. To grasp the intensity of the shear lag effect, multiple parameters were measured. The force and cross-head travel were observed as in any other tensile test. The strains were measured using different methods. First, tensile deformations were measured in the middle of the bars with an extensometer, with a base length of 55 mm. Second, the tensile strains were measured in the lower half of the bars with a camera using the digital image correlation method (DIC).
With the DIC method, the axial deformations on the surface of the FRP bars could be measured. The necessary length for the strains and, therefore, the stresses, to become evenly distributed was attained at the different diameters. To validate the DIC measurement, the data were compared with the strains measured by the extensometer.
The results showed that the shear lag effect is the most dominant near the anchorage and begins to decrease rapidly. Minor differences in the tensile strains remain longer, and the strains become even only found near the middle portion of the specimens.

SESSION 5 9:00–11:00

SMART HEALTH MONITORING OF CONCRETE BRIDGES USING DIGITAL TWIN AND AI APPLICATIONS

Asseel Al-Hijazeen, Kálmán Koris

Safety and sustainability of reinforced concrete bridges may be increased by observing their condition during operation and thus accurately predicting their behaviour under various load conditions. This can be achieved through a monitoring system and automatic error detection based on the measured data. By detecting potential issues early on, significant damages can be prevented before they occur. Despite extensive data collection from many monitored bridges, this data often remains unprocessed and uninformative in its raw form. We aim to transform this data into a format that can help to estimate a bridge's health condition. This approach is presented through a case study of an existing reinforced concrete box girder bridge in Hungary.
Digital twin (DT) technology was used to simulate the bridge's behaviour and to verify structural conditions under any given traffic load arrangement. Static calculations and verification of load-bearing and serviceability conditions were performed on a validated 3D finite element (FE) model. Different traffic load scenarios were randomly generated using Monte Carlo simulation, and the bridge's condition was evaluated

for each case. The actual condition was quantified by parameters such as the bridge's utilization for different USL and SLS limit values, especially for deflection and crack width. In the FE model, the physical characteristics that are recorded on the real bridge by the actual measuring instruments were also recorded at the locations corresponding to the monitoring points on the actual structure.
The relationship between the virtual bridge's condition and the virtual monitoring data was determined using artificial intelligence (AI) applications, particularly artificial neural networks (ANN). Based on this relationship, the monitoring data measured on the real bridge can be processed, and predictions about the bridge's actual condition can be made to support maintenance and improve the safety and sustainability of the structure. This approach demonstrates the potential of DT and AI in structural health monitoring techniques.

SESSION 5 9:00–11:00

THE SWEATING SLAB SYNDROME – A SCIENTIFIC ANALYSIS

Manfred Kehrer, Todd Nelson

The Sweating Slab Syndrome (SSS) was first mentioned in 2005 [3] and has further been discussed in [1], [2], [5], [6]. The condition is typically marked by the build-up of moisture in so-called big-box warehouse buildings on the top surface of concrete slab-on-ground construction which, when severe, can interfere with the routine operations of the facility, e.g. forklift traffic. The buildings are typically located in southern to southeastern regions of the United States and have non-climate controlled indoor environments. After drying, residues remain on the surface of the slab-on-ground, which have been identified as carbonation products of alkaline salts. Speculations as to the cause of this syndrome have included dew-point condensation, high vapor permeability of the slab, the troweling finishing process, bond breaker influence, unreacted silicates from integral or spray applied admixtures, and the absence of vapor retarder sheets under the slab. None of the speculated causes have been given supporting data or studied in detail, however.
To determine the cause of the SSS, Wiss, Janney, Elstner, Associates, Inc. (WJE) applied a standard scientific methodology in 2019 consisting of three parts. The first part of this methodology was to collect data through observation, instrumentation, numerical simulation, and laboratory analysis. Second, a set of hypotheses was generated based on the data collection and logic. Finally, collected data was paired with one or multiple hypotheses in a logical way to disprove or support their validity. Results will be shown.S

ABSTRACTS

ESSION 6 11:30–13:30

EXPERIMENTAL STUDY OF FRP REINFORCED LWC BEAMS

Balint Somlai, Sandor Solyom

Fiber reinforced polymer (FRP) rebars offer multiple advantages in concrete construction such as high tensile strength, corrosion resistance, low density and magnetic neutrality. Some properties of FRP reinforced elements such as the lack of plastic deformations before failure need to be addressed. The research into the behaviour of FRP rebars and FRP reinforced concrete elements has been ongoing for decades and has produced results that facilitated the construction of many structures utilizing this technology. There are, however, many areas that require further studies. FRP reinforcement combined with lightweight concrete (LWC) results in structural elements with reduced self-weight. This type of structural element can have reduced transportation and construction costs, as well as larger dimensions due to the reduced density. The goal of this research is to study the behaviour of FRP reinforced LWC beams by conducting laboratory experiments. Then using the data collected, along with data from previous experiments on FRP reinforced beams with normal weight concrete to build finite element models. These models are to be used to conduct further analysis on the behaviour of FRP reinforced LWC beams by studying the effect of various parameters such as the potential positive impact of the confinement effect on the concrete in the compressive zone to ensure a more ductile failure of beams designed to fail in compression. Special emphasis is to be placed on the parameters governing the changes in behaviour such as the quantity of shear reinforcement, concrete cover, or the dedicated confinement of the compression zone.

SESSION 6 11:30–13:30

DETERMINATION OF THE DEFORMATION BEHAVIOR OF CONCRETE STRUCTURES REINFORCED WITH FRP BARS: A THEORETICAL STUDY

Kateřina Mrkvová, David Vašátko, František Girgle, Petr Štěpánek

The design of concrete structures with embedded non-metallic composite reinforcement (FRP) is becoming more widespread. The behavior of statically determinate concrete structures reinforced by this durable material is already widely understood and known. Usage of glass and carbon fiber reinforcement is also included in the new generation of Eurocodes for concrete structures. However, in common practice, we also encounter statically indeterminate structures such as continuous beams or slabs. In the case of traditional steel reinforcement of continuous beams,

it is possible to assume a certain redistribution of bending moments and to use the principle of linear elastic analysis with limited redistribution in design. According to ACI 440.1R-15 and the new generation of Eurocode a moment redistribution of internal forces on continuous beams or other statically indeterminate structures reinforced with FRP reinforcement should not be considered, given the lower material stiffness and linear elastic behavior up to failure. However, in reality, a redistribution of internal forces can occur.
Based on a limited number of studies and experiments that have been carried out in this area globally, there is a premise that some degree of redistribution of bending moment may occur in FRP reinforced indeterminate structures. The objective of this work is to support this assumption through an analytical study of the behavior of a concrete cross-section reinforced with FRP bars, demonstrating its potential for internal force redistribution. The aim of this paper is to present the results of an analytical study capturing the behavior of a concrete cross-section reinforced with FRP, the determination of the deformation characteristics of such a section, and the possible application of the results to a two-span concrete beam. The main emphasis is placed on the stress-strain diagram of concrete and its influence on deformation characteristics, mainly moment-curvature relationship.

SESSION 6 11:30–13:30

THE USE OF CONCRETE WITH SIGNIFICANTLY REDUCED CEMENT CONTENT IN VARIOUS CONDITIONS ESPECIALLY HARD WINTER CONDITIONS

Pavel Kasal, Michael Härtel, Daniela Ehrenreich

The paper presents research project from Vienna, which investigates practical use of concrete with significantly reduced cement content and big amount of addition. The main part of experiments includes production of test structural elements in the field using ready mix concrete because a great emphasis was placed on practical use especially in residential sector. Six concrete mix designs were used: two mix designs with reduced cement content and high amount of addition, two contained additionally biochar, and two of them were reference mix design of "today" concrete mixes. Experimental part consist of autumn and winter tests. In the both cases twelve test structural elements were executed and different tests of fresh and hardened concrete were performed using prepared test samples and drilled cores. Concrete hardening took place most of the time in colder conditions. During the winter experimental part several winter measures were introduced to protect the concrete against very low temperatures (covering with a blanket, heating). Ambient temperature and concrete temperature during the hardening were continuously monitored and recorded. After the execution of all experiments, carbon dioxide footprint

of all executed test structures was calculated. Three concrete suppliers from Vienna and surroundings, construction and real estate company, architectural office, formwork supplier and other cooperated on the research project. The project was co-financed by the Austrian Research Promotion Agency (FFG) and city of Vienna (MA20).

SESSION 6 11:30–13:30

THE STIFFNESS ANALYSIS OF LIGHTWEIGHT CONCRETE DECK SLABS WITH GFRP REINFORCEMENT UNDER FATIGUE LOADING CONDITIONS

Agnieszka Wiater, Tomasz Siwowski

Glass fiber-reinforced polymer (GFRP) bars have been used in concrete bridge deck slabs as a replacement for conventional steel reinforcement, with the aim of solving the problem of corrosion and improving the service life of bridges. Lightweight concrete (LWC) bridge deck slabs decrease dead load, thus reducing foundation and substructure costs, enabling bridge strengthening during redecking, improving seismic structural response, and facilitating easier handling and transport. The advantages presented by GFRP composite reinforcement and LWC in the context of bridge deck slabs motivate further exploration into the potential synergies these materials offer for bridge construction and rehabilitation. Nevertheless, there has been limited experimental research on the performance of LWC bridge slabs reinforced with GFRP bars, particularly regarding fatigue behaviour. To address this gap, a series of experiments were conducted on full-scale bridge deck slab specimens subjected to both static and fatigue loading. These slabs, which measured 18 cm in thickness, 1 m in width, and 3 m in length, featured various reinforcement ratios and configurations. Fatigue loading was applied until failure or reached up to two million cycles at a frequency of 1 Hz. Post-fatigue, the specimens underwent static testing to evaluate changes in their behaviour. The results, focusing on deflection and stiffness at different cyclic load levels, highlighted the favourable fatigue performance achieved by lightweight concrete bridge deck slabs reinforced with GFRP bars.

SESSION 6 11:30–13:30

EXPERIMENTAL INVESTIGATIONS OF EFFECTS OF TRAFFIC-INDUCED VIBRATIONS ON YOUNG CONCRETE

Christian Gasser, Alois Vorwagner, Stefanie Klackl, Tanja Manninger

In the COUNT (Concreting under traffic) research project, the effects of traffic vibrations on young concrete have been extensively investigated.

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This research question has recently become more relevant since traffic closures often have to be imposed when bridges are renovated or widened, as there is a concern that the vibrations caused by traffic could damage the young (hardening) concrete. COUNT aimed to determine critical vibration values and underlying damage mechanisms based on three test series. Both harmonic and real bridge vibrations due to train, truck, and car traffic have been adopted. The effects on the material concrete itself have been investigated, as well as on the bond behaviour between concrete and reinforcement, and the bond between existing and new concrete parts.

SESSION 6 11:30–13:30

FINITE ELEMENT MODELLING FOR 3D CONCRETE PRINTING: FRAMEWORK AND EXAMPLES

Rymeš Jiří, Jendele Libor, Červenka Jan

This study describes a novel numerical approach for simulating the structural behaviour of 3D concrete printed elements. It assesses the structural integrity both during printing at an early age and the final mature state. The presented approach adopts the finite element method with a non-linear material model for realistic material response. The hardening of the printed paste is captured by progressively adjusting the material model parameters during the step-by-step solution. The 3D printing and load capacity assessment is analysed within a single analysis thus the deformation occurring during printing affects the predicted load-bearing capacity. Additionally, the approach utilizes interface elements to simulate potentially weaker connections between the printed layers.
The simulation framework is illustrated in two examples: a comprehensive 3D printing and load-bearing capacity analysis of a simple wall segment and a 3D concrete printing simulation of a single-story house structure.

SESSION 6 11:30–13:30

DURABILITY OF DRY BASALT YARNS IN DIFFERENT ALKALINE ENVIRONMENTS

Delara Etezad, Leonhard Randl, Agathe Robisson, Teresa Liberto, Philipp Preinstorfer

In this research, dry basalt yarns are prioritized due to sustainability reasons, despite the protective properties of the polymeric layer in impregnated yarns which would enhance durability. To better understand the durability of non-impregnated basalt fibers in different environments, dry basalt yarns were immersed and kept for 90 days in various pH levels solutions, namely citric acid, tap water, kaolinite filtrated suspension

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and ordinary cement filtrated suspension at 60°C to accelerate their degradation process. By monitoring the pH, mass changes, and the uniaxial tensile strength of the immersed basalt yarns, the damage progression and their durability were investigated both from a chemical and mechanical point of view. The basalt fibers showed better durability in the less harsh clay-based environment. This strengthens the potential applicability of dry basalt textiles in clay-based matrices.

ABSTRACTS

POSTER SESSION

P1

INVESTIGATING THE DURABILITY OF CONCRETE REINFORCED WITH WASTE TIRE STEEL FIBERS

Asad Zia, Ivan Holly, Jaroslav Prokop

This study explores the potential impact of waste tire steel fibers (WSFs) on the durability of concrete, specifically focusing on water absorption, carbonation, and split-tensile strength. The utilization of waste tire steel fibers in construction presents an opportunity to mitigate the escalating pollution stemming from discarded tires. While prior research has explored the incorporation of WSFs in concrete, comprehensive data on the properties of WSF-reinforced concrete over extended periods are lacking. To bridge this gap, the current study evaluates the influence of locally sourced WSFs from Bratislava, Slovakia, on concrete properties, with a particular emphasis on hardened properties beyond the conventional age of 28 days. Locally procured C20/25 concrete is employed, incorporating varying proportions (0%, 0.50%, and 0.60%) of raw WSFs in hybrid forms. The hybrid WSF formulation comprises 30% industrial steel fibers and 70% WSFs. Experimental assessments include elastic tensile splitting strength (SS), rapid carbonation depth (CD), and water absorption (WA) of specimens aged 600 days. Hybrid WSF reinforced concrete (HWFRC) demonstrates diminished carbonation depth and water absorption compared to plain concrete. Furthermore, the split-tensile strength exhibits enhancement relative to plain concrete. HWFRC showcases promising potential for substituting plain concrete in diverse civil engineering applications. Nonetheless, further investigations are imperative to ascertain the performance of HWFRC under severe environmental conditions.

P2

CREEP AND SHRINKAGE MEASURED ON DIFFERENT CONCRETES FOR BRIDGES

Vít Němčic, Jan L. Vítek

Creep and shrinkage of concrete are important parameters for verification of ultimate and serviceability limit states. The prediction models which can be found in design codes, are applicable for ordinary concrete types. Unusual concrete types, like e.g., white concrete can be used, but their properties should be investigated by experimental testing. The paper is focused on measurement of shrinkage and creep of white and grey concrete of the same strength class. The experiments showed that both, creep and shrinkage of white concrete are higher than those of ordinary

grey concrete. The measured shrinkage strains were compared with predicted shrinkage strains using various prediction models.

P3

MODEL UNCERTAINTY IN EUROPEAN UHPC STANDARDS: INSIGHTS FROM SIA-2052 AND NF P18-710 FLEXURE MODELS

Lenganji Simwanda, Miroslav Sykora, Jana Marková

This study explores the assessment of model uncertainty within European Ultra-High-Performance Concrete (UHPC) standards, focusing particularly on the flexure models outlined in Swiss SIA-2052 and French NF P18-710. Model uncertainty is calibrated by comparing predictions of these models against a comprehensive test database consisting of 211 UHPC beams reported to fail in flexure. Additionally, the characteristics of model uncertainty, including mean, coefficient of variation, and probability distributions, are discussed. The study also explores regression and correlation analysis between model uncertainty and basic variables. Finally, the implications of these findings for partial factor method verifications are explored. Limitations of this study and scope of application of the obtained results are discussed and needs for further research are outlined. This analysis contributes to the ongoing discourse surrounding UHPC standards, offering valuable insights for improving reliability analysis of new structures made of novel UHPC materials.

P4

THE EFFECT OF THE USE OF RECYCLED CONCRETE AGGREGATES ON THE PROPERTIES OF HARDENED CONCRETE

Adrián Ondák, Ivan Hollý, Jaroslav Prokop

The development of human society has seriously damaged the environment and may endanger its sustainability for the next generations. The exploitation of natural resources, in particular non-renewable resources, for construction purposes leads to millions of tons (Mt) of construction and demolition waste (CDW) every year. Research in the reusing of waste materials is of merit with growing awareness of the consequences of construction production to the environment. The use of waste material decreases the environmental impact of construction and demolition waste, reducing landfilling and rock mining, and, from a practical point of view, this practice provides new raw materials for making concrete. In this paper, the effect of using recycled aggregate concrete (RCA) on the basic properties of normal concrete is studied. Three types of concrete were studied: natural aggregate concrete (NAC), concrete

ABSTRACTS

with 50 % and 75% replacement of natural coarse aggregates by recycled concrete aggregate. Results showed that to use of recycled aggregates reduces the mechanical properties of hardened concrete. Concrete strength has been reduced by 35% to 55% depending on the percentage of the normal aggregate replaced by recycled aggregate. Concerning the tensile strength, for recycled aggregate concrete was lower by 6 – 36%. The different properties of hardened concrete with a rate of recycled aggregate also have an impact on the design process of the load-bearing structures of the buildings. Although the standard regulations allow the use of recycled concrete aggregate even today, many designers do not trust this material. However, we will not avoid the use of secondary raw materials in the design of new structures in the future. The knowledge on the use of recycled aggregate concrete, presented in this paper provides directions for both research and the concrete industry to systematically focus on sustainable concrete products.

P5

MINIMUM REINFORCEMENT AGAINST BRITTLE FAILURE IN CONCRETE STRUCTURES

Marta Słowik, Izabela Skrzypczak

The paper presents the rules for determining the minimum reinforcement in reinforced concrete structures that have been recommended in recent years and currently. It has been analyzed whether the reinforcement in structural members designed in different periods of time on the basis of various standard regulations regarding minimum reinforcement meets the conditions for protecting the structure against brittle failure. The necessary reinforcement has been determined using the method derived on the basis of nonlinear fracture mechanics of concrete. In the performed analysis the scale effect has been taken into account as well.

P6

PROPERTIES OF FIBERS AND MORTAR OF SLURRY INFILTRATED FIBER CONCRETE (SIFCON)

Wisam K. Tuama, György L. Balázs

Slurry Infiltrated Fiber Concrete (SIFCON) is a particular type of fiber-reinforced concrete with a high fiber content that shows high strength, with a significant improvement in properties such as durability, ductility, and toughness, which has greater energy absorption capacity along with good mechanical properties. In the last decade, much research has been conducted on SIFCON, mainly focused on changing the ratio, shape, or type of fibers to improve some mechanical properties and replacing some components of mortar of SIFCON to enhance its durability. In this paper,

ABSTRACTS

an attempt has been made to review the research results in improving the properties of SIFCON by using different types and quantities of fibers, as well as knowing the extent to which this type of concrete is affected by using alternative materials for mortar components. The review provides essential information about SIFCON that researchers in this field may encounter.

P7

COMPRESSIVE BEHAVIOR OF A HYBRID STEEL-CONCRETE JOINT FOR DISCRETE RETICULATED TIMBER STRUCTURES

Žiga Unuk

The paper presents a compression test of a hybrid steel-concrete joint for discrete reticulated timber structures. The hybrid steel-concrete joint consists of short steel tubes filled with plain concrete. The anticipated concrete strength class was C25/30. Compression tests were also conducted on empty steel tubes for comparison. The specimens were loaded perpendicularly to the steel tube's longitudinal axis, resulting in split-tensile-test-like loading of the concrete infill (cylinders). The study focused on the concrete infill's contribution to the load-bearing capacity and stiffness of the steel tubes. It was shown that a split-tensile crack occurs in the concrete infill at a certain load level, but it does not limit the load-bearing capacity of the joint as the steel tube provides sufficient concrete (infill) confinement. The stiffness and load-bearing capacity of the concrete-infilled specimen were magnitudes of the empty steel tube values. Two mathematical models were derived to calculate the compressive stiffness of the concrete infill before split-tensile crack occurrence. A curved beam model was used to calculate the compressive stiffness of the steel tube. The calculated stiffness values matched the experimentally derived stiffness values with great accuracy. A parametric stiffness calculation was also performed to gain deeper insight into the hybrid steel-concrete joint behavior. An equivalent steel tube wall thickness was calculated for an empty steel tube stiffness to match the stiffness of the proposed hybrid steel-concrete joint. It was shown that the proposed hybrid steel-concrete joint is superior to the empty steel tube with a thicker wall as the ratio of materials costs, embodied energy and embodied carbon of the two configurations is less than 1:4.

ABSTRACTS

P8

PROPOSAL OF A HEALTH MONITORING SYSTEM ON THE RC BRIDGE WITH CONFIRMED DEGRADATION

Muhammad Fawad, Kalman Koris, Marek Salamak, Dawid Piotrowski, Marcin Jasinski

Monitoring and structural health assessment are the primary requirements for the performance evaluation of damaged bridges. This paper highlights the case study of a damaged Reinforced Concrete (RC) bridge structure where the Finite element (FE) modeling of this structure was done using the material properties extracted by the in-situ testing. Analysis was carried out to evaluate the bridge damage. On the basis of FE analysis results, this study proposes a proper Structural Health Monitoring (SHM) system, that will extend the life cycle of the bridge with minimal repair costs and reduced risk of failure. This system is based on the installation of three different types of sensors: Liquid Levelling sensors (LLS) for measurement of vertical displacement, Distributed Fiber Optic Sensors (DFOS) for crack monitoring, and Weigh in Motion (WIM) devices for monitoring of moving loads on the bridge.

P9

PRELIMINARY RESULTS FOR PHYSICAL PROPERTIES OF CONCRETE BASED ON THE VARIABLE AGGREGATES PARTICLE DISTRIBUTION CURVE

Peter Czirak, Martin Palou, Jana Čepčianska

This paper discusses the influence of the aggregate on the overall properties of concrete. Well graded aggregates help to build up strong structure of material, however river sand and aggregates are natural resources with variable properties and granulometry and therefore it is important to understand, how a deviation from the ideal curvature influences the properties of concrete such weight, compression strength and modulus of elasticity. Methodology is based on the multiple mixes comparison, where cement, water and plasticizer additions are constant, overall weight of aggregate is constant and the only variable part is an aggregates particle size distribution curve. Proportion between fine, 0–4 mm and coarse 4–16 mm aggregates vary from 37% fine / 63% coarse, to 59% fine /41% coarse. Concrete mixes with six different distribution curves were prepared in total and twelve cubical specimens with dimensions 100×100×100 mm were cast for each mix. Samples were cured in a water tanks. Physical-mechanical properties were evaluated after 2, 7 and 28 days. As a support input an influence of cement on the compression strength in a time, cement samples were tested in the same

time intervals and compression strength according to EN 196-1:2016 was evaluated. This will support the findings about evaluation of the strength development. From the results is visible, that aggregate distribution has a major impact on properties of hardened concrete, with 28% difference between mixes with the highest and mixes with the lowest compressive strength at 2 days and with 11% difference at 28 days. The same experiment was performed with heavy weight concrete made with magnetite aggregate and sand, using the same distribution curves, mass of cement water/cement ratio and plasticizer. Similar trends were observed with 11% difference between mixes with the highest and mixes with the lowest compressive strength at 2 days and with 13% difference at 28 days.

P10

BRIDGE MODELLING AND STRUCTURAL ANALYSIS IN BIM

Jelena Bleiziffer, Marta Miloš

Digitalisation of the construction sector is one of the priorities in the European Union and one of the main technologies used for this purpose is Building Information Modelling (BIM). An important advantage of BIM is that it enables management of information about the built environment through all phases of the asset lifecycle: procurement, design, construction, operation and maintenance. Major promotion for the use of BIM in construction projects in EU member countries comes from the EU directive on Public Procurement and many public investments are related to infrastructure projects, including bridges. Indeed, in some countries, for certain public projects it is now mandatory to use BIM. This paper focuses on the implementation of BIM for bridges, which was overall much slower than for buildings. Some of the differences between BIM for bridges and BIM for buildings are pointed out, as well as what is identified as major barriers for implementation of BIM in bridge projects. At the same time, there are significant advancements with respect to openness and standardization on the international level, which are essential for widespread and effective use. Several software developers have taken on the challenge to provide bridge BIM solutions, some with the intention of using a single model for both physical representation of a bridge in blueprints and analytical calculations to design and verify mechanical resistance of the structure. This paper uses one such example to discuss current possibilities, some of the great advantages this technology offers, but also potential problems in the bridge BIM modelling procedure, when BIM model is used for structural analysis

WELCOME TO MIKULOV

WELCOME TO MIKULOV

Mikulov is a town in the South Moravian Region of the Czech Republic. It has about 7,700 inhabitants. The historic centre of Mikulov is well preserved and is protected by law as an urban monument reservation. Mikulov is located about 18 kilometres northwest or Breclav, on the border with Austria. Most of the territory lies within the Pálava Protected Landscape Area.
Mikulov is a centre of Czech wine making due to its favorable geographic location and climate, as well as its unique history. Mikulov is the centre and the namesake of the Moravian wine sub-region called Mikulovska wine region.

The main sight is the Mikulov Castle. The castle was built in the place of a Romanesque castle. At the turn of the 16th and 17th centuries, it was rebuilt in the Renaissance style, and in the late 17th century in the Baroque style.
The historic town square was founded in the late 16th century near the castle. It contains Renaissance houses from the first half of the 17th century.
The history of the Jewish community is presented by an educational trail through the old Jewish quarter. The synagogue, originally built in the 16th century and Baroque rebuilt after the fire in 1719, is the only preserved synagogue in Moravia of the so-called Polish type. The large Jewish cemetery is one of the most significant in the country.

USEFUL LINKS

The municipal website of Mikulov:
https://www.mikulov.cz/en/

Mikulov on Wikipedia:
https://en.wikipedia.org/wiki/Mikulov,
https://de.wikipedia.org/wiki/Mikulov

EXHIBITION

SOCIAL PROGRAMME

Social activites will include Welcome reception, Congress opening ceremony and Congress dinner.

EXHIBITION

A technical/commercial exhibition will be organized alongside with the Congress to demonstrate new technologies, materials, products and services. The exhibition will be located in a collateral hall located directly next to the main Congress Hall. All the organizations, individuals and whoever else interested in the exhibition are invited by the Congress secretariat. Exhibition information and the CCC2024 Exhibition Booth Application Form will be available on the Congress website and will be sent on request as well.

EXCURSIONS

After finishing the congress programme, on Tuesday afternoon, the excursion to Archeopark Pavlov – **https://www.archeoparkpavlov.cz/en/?langselect=1** will be organized. As it is just a 13-minute drive from Hotel Galant, where the congress takes place, we suppose you come there by your own cars, however, we are ready to order a taxi for you if necessary.