WMCCAU 2026

11TH WORLD MULTIDISCIPLINARY CONGRESS ON CIVIL ENGINEERING, ARCHITECTURE AND URBAN PLANNING

ABSTRACT BOOK

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Preface

This volume presents the Abstract Collection of the **11th WMCCAU 2026**, bringing together the abstracts of oral and poster presentations contributed to the World Multidisciplinary Congress on Civil Engineering, Architecture, and Urban Planning, held in Ostrava, Czech Republic, from **31 August to 4 September 2026**.

The 11th WMCCAU 2026 continues the congress tradition of promoting a multidisciplinary environment in which researchers, academics, professionals, and practitioners can share knowledge and explore new developments across Civil Engineering, Architecture, Urban Planning, and related disciplines. By connecting different fields and perspectives, the congress aims to stimulate discussion of contemporary challenges, innovative methods, practical solutions, and emerging directions for future research and professional practice.

An important objective of WMCCAU is to present new perspectives and promote best practices across a broad spectrum of topics, including **Civil Engineering, Architecture, Urban Planning, Accreditation, Archaeological Methods and Theories, Architectural Culture, Architectural Design and Methods, Heritage Conservation, Architectural Historiography, Spatial Architecture, Building Simulations, Planning Education, CAD, Construction Management, Construction Materials, Economics and Politics, Geotechnics, GIS-Based Modelling, Hydromechanics, Coastal Management, Quantitative Methods, Public and Regional Spaces, Risk Mitigation, Social Aspects of Architecture, Structural Engineering, Sustainability in the Built Environment, Theories of Vision, Transportation, Urban Design, Urban Sociology, and Station–City Integration**.

Beyond presenting research results, WMCCAU seeks to create an international forum for the exchange of ideas, experience, and expertise. The congress provides opportunities to establish new professional and scientific connections, strengthen existing collaborations, and encourage dialogue across disciplines and national boundaries. Particular importance is also placed on supporting early-career researchers by giving them the opportunity to present their work, receive valuable feedback, and engage directly with experienced researchers and professionals from around the world.

We sincerely appreciate the continued interest of the international scientific community in WMCCAU and would like to thank all authors, presenters, reviewers, session chairs, partners, and participants whose contributions make the congress possible. The diversity of institutions, countries, disciplines, and research perspectives represented at the 11th WMCCAU 2026 demonstrates the value of multidisciplinary cooperation in responding to the evolving challenges facing the built environment and our cities.

We hope that this Abstract Collection provides a valuable overview of the research presented at this year's congress and serves as a source of inspiration for further scientific discussion and collaboration. We also wish all participants an enjoyable and productive stay in Ostrava and the opportunity to experience the city's distinctive combination of industrial heritage, contemporary architecture, culture, and ongoing urban transformation.

We look forward to welcoming you again at the next edition of the **World Multidisciplinary Congress on Civil Engineering, Architecture, and Urban Planning – WMCCAU 2027**, to be held in Ostrava, Czech Republic, from **30 August to 3 September 2027**, continuing the tradition of bringing together the international scientific and professional community.

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ACCESSIBILITY IN THE BUILDING OF THE FORMER SCHOOL OF ARTS AND CRAFTS OF THE UNIVERSITY OF SANTIAGO OF CHILE

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ABSTRACT

The University of Santiago of Chile (USACH) has a single campus of 34 hectares in Santiago. Among its many buildings, the EAO (1893) stands out, which today houses the Department of Civil Engineering. In 1986, the building was declared a National Monument. Its architectural features correspond to neoclassical architectural style, noted for its solidity, masonry walls, and a classical structure that serves as a national monument, combining technical functionality with academic monumentality. The objective of this work is to carry out an accessibility assessment of the building over time, using as a technical tool the application of the Accessibility Diagnosis Index Report Form (IDA), created by the National Disability Service. Its methodology and evaluation criteria will allow for the establishment of a clear baseline to progressively, methodically, and systematically advance in the adaptation and implementation of adjustments and measures for universal accessibility. This tool aims to guide the evaluation and general diagnosis of accessibility through the identification of the most common barriers in the urban, architectural, informational, and inclusion environments, as well as the basic level of accessibility, based on the methodology established for this evaluation, which has been developed on the fundamental concepts of the “Accessibility Chain.”. After applying the IDA Report Form, and considering all current national regulations related to accessibility during 2019, several instances of non-compliance with the evaluated accessibility standards were found. A new assessment conducted in 2025 showed that although some corrective measures have been implemented, there are still serious issues regarding universal accessibility in the EAO.

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A GENERALIZED THREE-DIMENSIONAL DAM-BREAK FLOW

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ABSTRACT

The gravity driven three-dimensional flow as a result of a cavity collapse surrounded by a liquid is investigated for small times. Initially a finite cylindrical cavity of elliptic cross section is placed at a rigid bottom. The cavity is surrounded by a liquid from the top base to the bottom base of the cylinder. The liquid starting from the elliptical lateral surface extends to infinity in the radial direction and it is assumed to be inviscid and irrotational. Potential theory is used to describe the flow. Fourier series analysis reveals the singularity of the flow velocity at the intersection on the flow region with the dry surface.

The problem is solved at its initial stage immediately after the collapse, therefore asymptotic analysis is employed to solve the governing equations as $t \to 0$. The velocity potential satisfies the Laplace's equation, the kinematic boundary conditions at the free surface shapes and the rigid bottom, the dynamic boundary conditions at the free surface shapes, the conditions at infinity and the initial conditions. Elliptic cylindrical coordinates are used to express the initial boundary value problem. Fourier series method is employed to solve the Laplace's equation in elliptic coordinates. The method of separation of variables separates the angular and radial components yielding the Mathieu equation and the Modified Mathieu equation.

It is observed that the leading order initial value problem has a mismatch of conditions at the contact line, where the initially vertical free surface and the rigid bottom intersect. The solution reveals that the fluid velocity is logarithmic singular along this contact line, which is common for dam break problems where the fluid region touches dry surfaces. This problem aims to generalize three-dimensional dam break problems.

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AI-DRIVEN OPTIMIZATION OF INDOOR ENVIRONMENTAL QUALITY IN BUILDINGS: FROM DATA ANALYSIS TO ADAPTIVE CONTROL

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ABSTRACT

Indoor environmental quality (IEQ) is one of the most direct ways in which buildings influence the health, comfort and performance of their users, yet in many buildings it is still controlled mainly by delayed, threshold-based rules. Such operation is increasingly insufficient, because the individual IEQ domains do not behave separately. Indoor air quality, thermal comfort, visual comfort and the acoustic environment interact through ventilation, material emissions, daylight, occupancy and energy use, and a control action that improves one component may worsen another. This paper reviews how artificial intelligence (AI) and machine learning (ML) can support a shift from reactive monitoring to predictive and adaptive management of IEQ. The reviewed methods are discussed according to their practical role rather than as an isolated catalogue of algorithms. Classical supervised-learning models, especially random forests and support vector machines, remain useful where datasets are smaller, training speed is important and the result must be understandable for building operators. Deep recurrent architectures, including long short-term memory and gated recurrent unit networks, are better suited to sensor time series and have shown strong potential for short- and medium-term prediction of parameters such as CO_2, particulate matter and thermal conditions. Convolutional-recurrent hybrids extend this approach by combining the detection of local patterns with the modelling of their development in time. Deep reinforcement learning then moves from prediction to control, because it can learn HVAC strategies that balance comfort, air quality and energy demand. Physics-informed and hybrid models add physical constraints to data-driven learning and are especially promising where measured data are limited or operating conditions change. The paper also places these methods within an integrated IEQ management system that links IoT sensors, data cleaning, calibration, model training, inference, explainable AI, multi-criteria optimisation and feedback to the knowledge base. The reviewed evidence shows that AI can improve building operation, but only when reported performance is interpreted carefully. Very high prediction accuracies or energy savings usually depend on the specific dataset, building type, sensor quality and validation protocol. The main obstacles to wider use are heterogeneous and drifting sensor data, the lack of long-term standardised datasets, limited interpretability of deep models and the computational cost of continuous deployment. AI-based IEQ management is therefore most valuable when data-driven prediction is not used as a black box, but is combined with building-physics knowledge, transparent decision support and a clear understanding of the real behaviour of the indoor environment.

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ALKALI-ACTIVATED CLAY COMPOSITES AS LOW-CARBON MATERIALS FOR SUSTAINABLE CONSTRUCTION AND ARCHITECTURAL APPLICATIONS

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ABSTRACT

Alkali-activated clay composites represent an emerging class of low-carbon construction materials which combine clay-based resources, aluminosilicate reactions, and circular use of materials. In this context, this study explores alkali-activated clay composites as candidates for sustainable construction and architectural applications. The paper is formulated as a targeted literature review of materials, derived from a broader review of clay-based composite materials, focusing specifically on alkali-activated systems. The literature review covers material science fundamentals, mechanical and durability properties, thermal properties, environmental impacts, architectural applicability, and technical limitations.

In the reviewed literature, alkali-activated clay composites have been shown to be different from the stabilized clay systems because of their dependency on a chemical transformation process, as opposed to only physical strengthening or additive stabilization. The process of forming such composites is based on the dissolution of reactive silica and alumina of clay-based or aluminosilicate-containing raw materials through alkaline reaction followed by formation of N-A-S-H, C-A-S-H, or C-S-H binders. Important factors affecting performance include clay minerals composition, calcination conditions, type of activator and its concentration, liquid-to-solid ratio, calcium content, curing conditions, and porosity characteristics. Experimental studies conducted with calcined clay-rich sediments and mixtures with fly ash or slag indicate that the material under consideration may reach desired performance levels for certain construction purposes depending on proper mix proportioning and curing.

Environmentally, alkali-activated clay composites may contribute to a circular construction strategy based on local clay resources, construction residuals, water-treatment sludges, fly ash, slag, and other waste materials as sources of raw materials. At the same time, their environmental value will depend on the whole material cycle, which comprises calcination, activator manufacturing, curing, transportation, and disposal. From the architectural standpoint, the main application opportunities relate to the use of the material in non-structural blocks, panels, mortars, plasters, prefabricated items, envelopes, and certain repair mortars compatible with heritage architecture. It may be concluded that the use of alkali-activated clay composites cannot substitute concrete as an all-purpose construction material. Instead, this new material class is worth considering due to a combination of its low carbon footprint, local and waste-based materials, and architectural application opportunities.

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ANALYSIS OF A NOISE BARRIER WALL LOADED BY WIND

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ABSTRACT

The presented contribution analyses the wind flow in interaction with a noise barrier. In the current period, with regarding to human well-being and environmental ecology, noise barriers are being built around linear transport structures. This contribution deals with noise barriers on railway lines.

A noise barrier, as a linear structure on a railway line, is designed from two separate or mutually influencing air flows.

The first wind flow is the attack of the wind flow when a train passes. This is given by the European Union standards. The air pressure when a train pass is calculated according to the standards and depends mainly on the speed of the moving train and the distance of the noise barrier from the track axis. The first vehicle creates pressure on the obstacle, the following cars cause suction. These combinations depend on the type and arrangement of the individual cars of the train.

The second load is a separate wind in nature and on the specific terrain. The territory of Slovakia is divided into two main areas, where the basic wind speed is given: $v_{b,0}$ = 24 m/s, $v_{b,0}$ = 26 m/s

Then it is necessary to consider the terrain category. In Slovakia, due to the shape of the territory, we have 5 terrain categories (in order: 0, I., II., III., IV.)

An equally important factor is the question of the construction of the noise barrier itself. It is a free-standing wall. The free-standing wall is divided into 4 zones A, B, C, D. The individual zones have different pressure coefficients $c_{p,net}$.

The magnitude of the wind pressure also depends on the position of the noise barrier. Whether the track and the noise barrier are on a level surface, or the railway track is on an embankment. In the case that the noise barrier is built on an embankment, elevated compared to the surroundings, this fact must be taken into account through the orographic coefficient c_o. This will increase the average wind speed v_m on the elevated embankment compared to the average wind speed over flat terrain. The relationships are given in the standard regulations in Annex A.

As mentioned above, the two phenomena, the pressure from the train passing and the wind, can act separately or together. Due to the constant wind in one direction and the impact of air from a passing train, it is necessary to add or subtract these two events.

A combination of wind flowing from the track axis to the noise barrier may occur. When a train passes, this wind flow is interrupted and air pressure from the train is considered. When wind flows from open terrain, it is necessary to add or subtract the effects in some cases.

After obtaining the combination of loads, it is possible to proceed to the static analysis of the noise barrier structure itself. Or rather, the parts of the panels from which the wall is assembled.

The result of the static analysis is the optimal design of the individual sandwich panels from which the noise barrier is assembled.

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ANALYSIS OF THE MECHANICAL RESPONSE OF FOAMED CONCRETE UNDER COMPRESSION USING DIGITAL IMAGE CORRELATION AND PERIDYNAMIC MODELLING

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ABSTRACT

Foamed concrete is a lightweight cementitious composite. Foamed concrete is used in construction primarily for non-structural purposes, including for levelling and insulating layers and as a void filler. Foamed concrete can also be used to transfer load to other layers in the structure, such as road pavements. In such applications, the behaviour of this composite under mechanical loading is crucial, including the deformation pattern, damage location, and the nature of sample degradation. The aim of this research was to analyse the deformation and damage development of foamed concrete under compression using digital image correlation and peridynamic modelling.

In this study, foamed concrete was produced using CEM II/C-M (V-LL) 32.5R multicomponent cement. The foamed concrete was compressed. During the test, the load and displacement patterns were recorded. The specimen surface was observed using digital image correlation (DIC). The DIC method enabled the assessment of displacement and strain fields, as well as the identification of areas of deformation concentration and damage initiation during load increment. The obtained experimental results were used to analyse a macroscopic, nonlocal peridynamic model of foamed concrete. This model was applied to describe the response of a porous composite without directly representing individual pores. Comparison of the results of the compression test, DIC analysis, and numerical simulations allows for the assessment of the feasibility of modelling the composite's mechanical response, deformation distribution, and failure modes of foamed concrete. The proposed approach combines classical compression testing with image analysis and nonlocal modelling. This allows for extending the interpretation of foamed concrete test results beyond the standard assessment of compressive strength towards describing the mechanism of deformation and material degradation under load. The obtained results can provide a basis for further research on the behaviour of lightweight cement composites with a porous structure using experimental and numerical methods.

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ANALYSIS OF THE PERCEPTION OF INTERDISCIPLINARITY IN RESEARCH AND EDUCATION IN RELATION TO THE CURRENT TREND OF SUSTAINABILITY

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ABSTRACT

Nowadays, it is extremely important to take into account the needs of the digital age, which has completely absorbed not only young people and students and is among the priority information channels for absorbing information. In order to engage students and attract their greater attention to the study itself but also to research, it is necessary for the pedagogical process to be based on their needs and the needs of practice. In connection with the constantly increasing need for interdisciplinarity, a survey was created focused on the perception of interdisciplinarity understood by students in connection with education and research. Analysis of the findings resulting from the survey will help to understand students' priorities and their understanding of interdisciplinarity.

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AN APPROACH FOR LONGITUDINAL FRACTURE ANALYSIS OF CONTINUOUSLY INHOMOGENEOUS SHAFTS UNDERGOING FORCED TORSIONAL VIBRATIONS

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ABSTRACT

As is known, there are many situations in which various members of building structures are subjected to torsional loads. In addition, torsional loaded members, such as shafts having a circular cross-section, are widely used in various mechanisms, lifting machines, cranes and others in the construction industry. Therefore, the safe and reliable operation of structures and mechanisms largely depends on whether the strength, stiffness, stability, fracture resistance and durability of the members operating in torsion are ensured. This fact is an indication of how important it is to develop approaches for analyzing various aspects of the behavior of these structural members. One of the specific aspects is the longitudinal fracture of shafts experiencing forced torsional vibrations. Another aspect that is gaining increasing importance in our time is the application of continuously inhomogeneous materials for the construction of shafts operating in torsion. In view of the above facts, the purpose of this paper is to analyze the longitudinal fracture of shafts made of continuously inhomogeneous materials. The shaft under study experiences torsional vibrations. A circular disk is attached to it at one end of the shaft. A longitudinal crack was found in the shaft, which has the shape of a circular cylindrical surface. An approach is presented for finding the strain energy release rate (SERR) in the shaft taking into account the dynamic effects of forced vibrations. A solution published in the technical literature in the field of fracture mechanics has been applied to prove the approach. A parametric study has been performed showing how the SERR changes depending on the characteristics of the vibrating shaft. This paper may be useful in analyzing the longitudinal fracture of inhomogeneous shafts experiencing forced vibrations.

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AN INTEGRATED AUTOMATION SYSTEM FOR RESILIENCE VALIDATION OF COGNITIVE AUTONOMOUS PAVEMENT INFRASTRUCTURE

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ABSTRACT

Climate change fundamentally alters the operating environment of pavement infrastructure through non-stationary hydrothermal loading. This critically challenges the assumptions underpinning conventional pavement management systems. Existing validation approaches remain largely dependent on historical observations and deterministic deterioration models, limiting their ability to establish the credibility of the infrastructure model under unforeseen climate conditions where empirical observations do not yet exist. This paper develops a Prospective Resilience Validation (PRV) methodology integrated within a Cognitive Autonomous Pavement Infrastructure (CAPI) framework, conceptualising road networks as adaptive physical systems capable of continuous perception. To advance infrastructure intelligence and decision support, the framework incorporates edge-computing multi-temporal data analysis, combining near-real-time sensing, a stratified seven-layer pavement representation, Kalman-based data fusion, and deep learning models to process 100 Hz sub-surface sensor data. This approach accounts for future climate scenario evaluation to continuously assess structural condition and resilience. Unlike conventional validation approaches that measure agreement with historical observations, the proposed methodology evaluates the credibility of the model across ensembles of future hydrothermal scenarios that represent plausible environmental loading conditions. A scenario-based case study evaluates pavement performance under three representative climate futures comprising:

(i) moderate hydrothermal shifts (+1.5 ◦C with increased precipitation variability),
(ii) extreme hydrothermal loading associated with a 100-year flood event, and
(iii) compound hydrothermal stress (+3 ◦C with intensified rainfall variability).

Results demonstrate physically consistent deterioration trajectories across all scenarios, with projected permanent deformation increasing from 6-9 mm under moderate climate stress to 11-15 mm under compound climate loading, accompanied by significant degradation in International Roughness Index (IRI) performance. The proposed framework achieves a Scenario Resilience Score (SRS) of 0.94-0.98, outperforming conventional observation-based validation models with a baseline score of 0.72-0.78 under identical non-stationary climate conditions by 20-30%. This enables a more robust and stable model behaviour across diverse future climate scenarios while providing greater confidence in resilience assessment than conventional observation-based validation. These findings establish a scalable, self-evaluating infrastructure that should be validated not only against historical performance but also against plausible future operating conditions. The proposed methodology establishes a scalable foundation for climate-adaptive pavement management, risk-informed maintenance planning, and prospective infrastructure validation under non-stationary climate uncertainty.

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A NON-PARAMETRIC DATA SELECTION FOR ADJUSTMENT OF LEVELLING NETWORKS IN DEFORMATION ANALYSIS

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ABSTRACT

To enhance the reliability of deformation monitoring results, height differences in levelling networks are typically measured twice in opposite directions during each epoch, and their mean is used in least squares estimation (LSE) when the discrepancy between observations falls below a predefined threshold. However, this averaging process, combined with LSE, can create conditions that mask outliers, potentially compromising conclusions about vertical deformation. Because either of the two reciprocal height-difference observations generally has a smaller true error than their average, often more than 66% of the time, selecting the more precise observation is preferable to averaging. This study introduces a new robust adjustment method for levelling networks in deformation analysis that identifies optimal input data by evaluating closing errors across all loop combinations within the network.

The proposed approach systematically examines alternative observation sets derived from reciprocal measurements and selects those that minimize internal inconsistencies, as reflected by loop misclosures. In doing so, it effectively avoids the dilution of gross errors that may occur through averaging and reduces the influence of contaminated observations prior to adjustment. Unlike conventional robust estimators, which attempt to down-weight outliers during the estimation process, the method operates at the data selection stage, ensuring that only the most reliable measurements contribute to the final solution.

Using extensive Monte Carlo simulations, the proposed method is compared with LSE, MM-Estimation, and S-Estimation with breakdown points of 50% and 10%. The simulations consider varying levels of noise, proportions of outliers, and network configurations representative of practical deformation monitoring scenarios. The results demonstrate that the new approach consistently outperforms robust estimators in terms of accuracy and stability, particularly in the presence of multiple or subtle outliers, while remaining fully compatible with LSE when the data follow a pure Gaussian distribution. These findings suggest that the method offers a practical and reliable alternative for high-precision deformation analysis.

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APPLICATION ISSUES OF THE WINDOW ANALYSIS METHOD

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ABSTRACT

This study primarily identifies problematic issues of the window analysis method in construction schedule delay analysis and suggests an improved approach reflecting actual project implementation practices. The window analysis technique is one of the most acceptable, accurate, and reliable technique for analysing delay effects. However, its practical application in actual projects poses challenges. In real-world projects, practical constraints make adhering to the technique's requirements challenging. The difference between theory and practical application can lead to incorrect decisions in delay claims. The window analysis method assumes an unchanged as-planned schedule beyond each window period, but in practice, contractors update schedules to compensate for earlier delays while maintaining the original completion date. This practice brings shorter durations of activities in subsequent window. This ultimately results in a delay even if contractors complete those activities in the subsequent window within its initially planned duration. This means shifting the responsibility for the delay from the previous window to the activities in the succeeding windows. These effects should be analysed by tracking details of the duration changes. Through a case example, this study identifies these limitations. The findings provide delay analysts with insights into identifying and addressing problems associated with the window analysis method.

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APPLICATION OF MAGNETOMETRIC METHODS FOR DETECTING SUBMERGED METALLIC POLLUTION: CASE STUDY OF RADACINOSU, TREI IEZERE AND LA AMIAZA LAKES (DANUBE DELTA)

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ABSTRACT

One of the most effective non-invasive geophysical techniques for detecting and characterizing buried or submerged ferromagnetic objects is the magnetometric method, widely used in marine, environmental, and archaeological applications. Identifying sources of metallic pollution in sensitive ecosystems such as the Danube Delta is essential for assessing ecological risks and implementing remediation measures. The importance of applying high-resolution magnetometric investigations in Radacinosu, Trei Iezere, and La Amiaza lakes is highlighted in this study, which aims to detect anthropogenic metallic objects accumulated in sediments.

Magnetic data acquisition was carried out using a cesium vapor marine magnetometer (Geometrics G-882), correlated with a proton precession base station for diurnal variation correction and a high-precision TRIMBLE GNSS positioning system. The investigations enabled the acquisition of dense and continuous datasets, which allowed the generation of magnetic field variation maps through processing and interpolation techniques. During data interpretation, 3D modeling of magnetic anomalies revealed the presence of ferromagnetic bodies located at depths between 1 and 5 m, with variable dimensions and spatial distributions, especially in channel areas.

The results demonstrate the efficiency of the magnetometric method in identifying sources of metallic pollution, such as abandoned fishing gear, metallic components resulting from dredging activities, or possible submerged vessels. A particular case is represented by Radacinosu Lake, where anomalies corresponding to moderately sized objects were identified, either dispersed or linearly distributed, suggesting anthropogenic interventions during different periods. The extensive distribution of anomalies in Trei Iezere Lake indicates accumulations of metallic objects associated with historical industrial fishing. Well-defined and modeled anomalies in La Amiaza Lake indicate the presence of bodies with clear geometry and shallow depths, confirming the high potential of the method for precise detection of submerged objects.

According to international literature, marine magnetometry is recognized as a standard method for detecting shipwrecks and submerged metallic infrastructure, due to its high sensitivity and ability to rapidly cover large areas within a short time. Furthermore, 3D modeling allows the estimation of the shape, size, and depth of magnetic sources, contributing to robust interpretation and reducing uncertainties.

The application of magnetometric methods in Danube Delta lakes provides a dual benefit: on one hand, it enables the identification, mapping, and quantification of metallic pollution; on the other hand, it contributes to preventing risks associated with dredging and navigation activities. In other words, identifying these objects is essential for assessing their impact on aquatic ecosystems, considering the processes of bioaccumulation and toxicity associated with heavy metals.

In conclusion, magnetometric investigations represent an essential tool for environmental monitoring in lacustrine areas of the Danube Delta, offering a rapid, accurate, and non-invasive method for detecting metallic pollution and supporting the development of effective environmental management and conservation strategies.

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APPLICATION OF TIME-LOCATION DIAGRAMS IN LINEAR INFRASTRUCTURE PROJECTS – OLD WAYS OR NEW BEGINNINGS

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ABSTRACT

Weather speaking of planning, design, or execution and monitoring stages in linear infrastructure projects, the imperative is having accurate information of working locations for the efficient resource planning, safety of the construction site and monitoring of weekly progress. Such is missing in the existing scheduling methods, such as Gantt chart, Critical Path Method or Program Evaluation Review Technique, and their utilization on day-to-day work where construction managers have to depend on the subjective decisions for resources allocation and progress monitoring from location aspects. This has caused uncertainties in planning and scheduling that often result in construction delays and cost overruns of projects. The reasons lie in the nature of the work activities that are in linear project fundamentally different compared to ones in residential houses of high-rise building projects. To solve such problems application of time-location diagrams happens to offer those insights. Unfortunately, in recent years their application in Croatia have been neglected. Therefore, this paper focuses of time-location diagrams and showcasing development possibilities and capturing spatial dynamics with intuitive, precise and practical tool that will provide managers with effective information to support their decisions. To support aforementioned goal, the general overview of application of time-location diagrams will be discussed to seek the answer to the ultimate question: Is this method still appropriate?

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A PREDICTIVE MODELING FRAMEWORK LINKING BET TEXTURAL PROPERTIES TO STORAGE STABILITY OF BIO-MODIFIED BINDERS

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ABSTRACT

The storage stability of bio-modified binders is a key factor in the performance and durability of sustainable pavement materials, yet the factors governing phase separation remain poorly understood. This study investigates the influence of the textural properties of solid-state bio-modifiers on the storage stability of binders at elevated temperatures over extended periods. The objective was to determine how structural parameters such as surface area and pore volume affect binder behavior and whether these properties can serve as predictors of phase separation. Five bio-modifiers—Kraft lignin, microchlorella, rice husk, olive waste-derived biochar, and pulverized rice husk—were characterized in terms of surface area, total pore volume, and pore size distribution using the Brunauer–Emmett–Teller (BET) method and Density Functional Theory (DFT). Multiple linear regression models were then developed to relate these textural characteristics and bio-modifier content in each binder to storage stability, expressed as the softening point difference (°C) during the storage stability test. The reliability of the models was evaluated using statistical diagnostics, including the Shapiro–Wilk test and Q–Q plots for normality of residuals, residuals versus fitted value plots for homoscedasticity, and the Akaike Information Criterion (AIC) and Bayesian Information Criterion (BIC) to assess model fit while accounting for complexity. The results revealed that bio-modifiers with high surface area and large pore volume, particularly biochar, enhance binder adsorption on particle surfaces and promote particle aggregation. This increases the effective density of the particles and accelerates sedimentation, ultimately leading to significant phase separation during storage. While both BET surface area and total pore volume were found to significantly influence storage stability, surface area emerged as the stronger predictor of phase separation. In conclusion, the findings establish a clear link between the textural properties of bio-modifiers and the storage stability of bio-modified binders. Quantifying surface area and pore volume allows for the prediction of phase separation tendencies, and statistical modeling using multiple regression diagnostics provides a robust framework for evaluating binder behavior. These results offer practical guidance for selecting and designing bio-modifiers to improve the performance and durability of bio-modified binders, supporting the development of sustainable pavement materials.

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ARCHITECTURE OF CONTROL: SPATIAL MECHANISMS OF DISCIPLINE AND SEGREGATION IN THE EUROPEAN CONTEXT

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ABSTRACT

Architecture has never been a neutrally organized environment; since the beginnings of societal institutionalization, it has served as a primary instrument for directing, controlling, and isolating the human body. In the context of European modernity - from historical Enlightenment projects to contemporary urban strategies - physical walls, zoning regulations, and visual corridors have functioned as essential tools through which state and institutional powers enforce social discipline. Understanding these spatial relationships is vital for a critical analysis of how the built environment actively shapes power hierarchies and personal liberty.

This research systematically investigates and categorizes architectural typologies explicitly designed for control, surveillance, and isolation. The primary objective is to uncover parallel spatial principles between historical carceral institutions such as prisons and correctional facilities and late-modern institutions of a different character, including psychiatric wards, quarantine stations, and segregated urban enclaves found in modern European metropolises, while analyzing their impact on individual behavior and psyche.

The methodology utilizes a comparative analysis of architectural floor plans and spatial sections, with a particular focus on Jeremy Bentham’s concept of the Panopticon as a paradigm of institutional design. By applying the theory of space syntax and Michel Foucault’s concept of "biopower" - the way in which institutions manage human life - the study examines levels of visual permeability, accessibility, and physical movement restriction across various building types.

The research demonstrates that the architecture of control operates through three fundamental spatial principles: the asymmetry of visibility (where the controlled subject is exposed to view but cannot see the controller), forced linear circulation (where movement is restricted to predefined paths without the possibility of choice), and cellular compartmentalization (the isolation of individuals into small units to prevent collective interaction). The findings reveal that while modern institutions have undergone a process of visual "humanization" and physical barriers are often replaced by invisible or technological systems, the underlying geometric logic of control and exclusion remains fundamentally unchanged, effectively shaping daily behavioral patterns.

Architecture is an active political agent; isolation and control are directly inscribed into spatial morphology. These findings open a critical discussion for contemporary architectural practice regarding how to prevent the unconscious design of repressive spaces. In an era when European society faces increasing polarization, it is vital to shift toward creating inclusive and liberating environments. The work advocates for the design of spaces that foster social cohesion and mutual trust, ensuring that future architectural development prioritizes accessibility and the dismantling of hidden segregationist structures.

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ARTIFICE OF VEILING AND UNVEILING: NARRATIVE APPLICATION OF THE PICTURESQUE AESTHETIC IN ARCHITECTURE

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ABSTRACT

Throughout history architecture cyclically glided between static and dynamic design approaches. The first, being a manifestation characterized by a cartesian-like disposition of its elements, would eventually deform by the movement of its elements. This dynamic second stage involves understanding the initial rationale through an exercise of abstraction, or essentialization – the search for a so-called 'essence' of the object. Thus, the second stage is, historically, determined by the first. Pursuing the idea of essence, architectural discourse lean towards exalting a 'correct solution' of structure, materials or function; criteria that would evoke the projects core; its essence. However, architecture assumes something beyond analytical correctness or quantifiable qualities. It must have an expression that binds its components through certain interpretation, or narration. This expression involves an aesthetic approach, even as an artifice, which emphasize its message, and ultimately its meaning. More so, artifice does not invalidate the essence of the object, but it unveils it, disclosing it in a layered way. Thus, the architectural object reveals itself visually and kinetically through curated steps, through a specific narration that binds the elements of the architectural object.

The hypothesis of this paper is that the aesthetics artifice of the architectural object, such as movement and deformation of an initial clean-cut object, could be employed to develop a narrative exposition, which brings with it a sense of meaning or belonging. Earlier theoretical outlines regarding an aesthetic appreciation of movement appeared in the late 18th century English aesthetic debate of the picturesque. It influenced and provided the vocabulary for later spatial theories, from Camillo Sitte's *Städtebau* to Nikolaus Pevsner's critical writings on modernist urban practices and the birth of the *townscape* method, but it can be recognized in recent architectural instances also. This paper will examine some of late modernist and recent architectural instances that evoke, through an adaptive and intentional design approaches, a narration. The picturesque aesthetic theory provides the conceptual framework for an operational definition valid in architecture, as it embraces the artifices of the site, function, or the vernacular intervention. Through those artifices, the initial object undergoes certain deformations that conceal the original body, offering a new layer of experience. Exploring the influence and presence of the picturesque aesthetic ideal in contemporary architecture, it could be regarded as an operational instrument for concepts, guiding towards an engaging architecture.

By investigating the intentional act of variety, irregularity and intricacy of forms, architecture engages curiosity regarding the origin, and process of becoming of its resulted object – its aesthetics becomes a narrative interest. In this sense, the picturesque characteristics of movement or deformity generate a story, appealing to our own imagination, and ultimately a meaning, and attachment. It contrasts landmarks, pointing out a certain path and conferring a sense of orientation, through which the narrative lecture of the space can happen.

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ARTIFICIAL INTELLIGENCE AND BIM AS DIGITAL ENABLERS OF CIRCULAR ECONOMY IN CONSTRUCTION MANAGEMENT: EVIDENCE FROM A LONGITUDINAL SURVEY STUDY

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ABSTRACT

The construction industry faces a dual imperative: accelerating its digital transformation while simultaneously aligning with circular economy principles and decarbonization objectives. Artificial intelligence (AI) and Building Information Modelling (BIM) represent key enabling technologies in this transition, offering transformative potential for optimizing resource use, reducing construction waste, extending the lifecycle of materials and components, and supporting data-driven decision-making across all project phases. Despite this potential, the actual extent of AI and BIM adoption in construction practice, particularly in the context of circular economy goals — remains insufficiently understood in the Central European context. This paper presents findings from a longitudinal empirical study examining adoption levels, perceived impacts, and key barriers related to AI and BIM implementation in the construction industry, with a specific focus on their role in supporting circular construction practices. The research is conducted within the framework of an APVV research project focused on digital technologies and BIM-based tools for multi-dimensional modelling and evaluation of sustainability parameters in buildings, with emphasis on decarbonization and circular construction. Two consecutive structured questionnaire surveys were conducted with construction industry professionals in 2024 and 2025. The surveys captured data on AI tool awareness and utilization, perceived impact across construction phases (design, execution, and facility management), expectations regarding AI in waste management, materials optimization, and logistics, digital and AI competency levels, and primary obstacles to digital transformation. In 2025, the survey was extended to include company-level digitalization maturity, AI training readiness, and perceptions of AI's role in circular process automation and intelligent planning. Results indicate measurable growth in both AI awareness and utilization between the two survey periods. Respondents increasingly recognize AI's potential in construction project management, scheduling, cost control, materials optimization, and waste reduction — all central to circular economy objectives. However, a significant gap persists between individual AI competencies and organizational digitalization readiness, reflecting systemic deficiencies in professional training and strategic adoption planning. Workforce competence and data security remain the principal concerns. The findings provide evidence-based insights into the current state of AI and BIM readiness in the construction sector and their relevance to circular economy transition. They contribute to the formulation of targeted digital transformation strategies that support sustainable, low-carbon, and circular construction practices, in alignment with European Green Deal policy directions and circular economy action plans.

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ART IN PUBLIC SPACE BETWEEN VIRTUALITY AND REALITY: INTEGRATING DIGITAL, VR, AND AR TOOLS IN CURATING ART IN THE CITY

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ABSTRACT

The relationship between art, public space, and digital technology is increasingly reshaping how cities produce, experience, and curate culture. As urban environments undergo social, spatial, and institutional transformation, digital tools such as Geographic Information Systems (GIS), Virtual Reality (VR), and Augmented Reality (AR) are opening new possibilities for expanding the presence, accessibility, and interpretation of art in the urban realm. Public art is no longer limited to physical installations but is emerging as a hybrid field where material and virtual layers interact, creating new forms of cultural experience and engagement.

This research investigates how digital technologies can be integrated into the planning, mediation, and curation of art in public space. It proposes a methodological framework that combines spatial analysis, digital documentation, and immersive visualization tools to support new models of cultural production and participation. By linking physical sites with virtual content, digital platforms can extend the spatial, temporal, and social dimensions of public art, enabling audiences to access artworks beyond their material constraints and to engage with them in more interactive and inclusive ways.

The study adopts an interdisciplinary approach, bringing together perspectives from architecture, urban studies, digital heritage, and curatorial practice. Methods include literature review, comparative analysis of contemporary public art strategies, GIS-based cultural mapping, and the development of VR and AR prototypes to simulate and interpret site-specific artistic interventions. A participatory dimension is also emphasized, highlighting the role of artists, cultural institutions, and local communities in shaping digitally mediated public space.

The research argues that the integration of digital technologies into public art practices can contribute to more inclusive cultural participation, strengthen urban cultural identity, and support sustainable models of urban regeneration. By offering tools for anticipation, visualization, and interpretation, VR, AR, and GIS can help cities curate culture in ways that are more responsive to contemporary urban life and digitally connected audiences. The proposed framework is conceived as transferable and adaptable to different urban contexts; its future implementation and testing will include Sarajevo as one of a case study for exploring how hybrid digital–physical approaches can enrich the relationship between art, public space, and urban cultural development.

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ASSESSING THE IMPACT OF POLYPROPYLENE FIBERS ON THE CARBON SEQUESTRATION OF CONCRETE

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ABSTRACT

Combating climate change and reducing greenhouse gas emissions compel the modern construction industry to develop more sustainable and environmentally friendly solutions. In this context, carbonation—a natural process in which concrete captures and stores carbon dioxide (CO_2) within its structure throughout its service life—presents a significant potential for carbon sequestration strategies. This study investigates the impact of 50 mm long polymeric (polypropylene) fibers on the carbon sequestration capacity of concrete through accelerated carbonation testing. Within the scope of the research, concrete specimens containing polypropylene fibers at various volumetric fractions (0.3%, 0.64%, 1.0%, and 1.3%) were produced alongside fiber-free control specimens. The weight changes of the specimens before and after the carbonation process were precisely measured to quantitatively determine the amounts of trapped CO_2.

Experimental results demonstrated that fiber addition and dosage variations directly influence the carbon capture performance of concrete, creating distinct differences in weight gain. Concrete groups containing 0.3% and 1.3% polymeric fibers exhibited higher average weight increases (1.86% and 2.25%, respectively) compared to the control specimens (1.75%). This indicates that specific fiber networks optimize micro-cracks and the pore structure within the concrete, thereby accelerating CO_2 diffusion and enhancing carbon sequestration capacity. Conversely, a slight decrease in carbon retention (1.69% and 1.68%) was observed at intermediate dosages such as 0.64% and 1.0%, pointing to a non-linear relationship between fiber volume fraction and carbon absorption. In conclusion, the use of 50 mm long polymeric fibers at optimized dosages not only improves mechanical performance but also enhances CO_2 capture potential, offering a sustainable alternative for the construction sector to mitigate the adverse effects of climate change.

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ASSESSING URBAN DEVELOPMENT CAPACITY UNDER WATER CONSTRAINTS: A PLANNING-ORIENTED INDEX FOR SPATIAL POLICY

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ABSTRACT

Rapid urbanization and increasing pressure on water resources challenge the sustainability of conventional spatial planning practices. Traditional approaches, primarily based on functional zoning and post hoc infrastructure design, often neglect the dynamic relationship between urban development and water availability. This has led to overdevelopment in many regions—particularly coastal and tourism-intensive areas—where water demand exceeds supply capacity, resulting in resource stress and reduced system resilience. This study proposes a novel planning-oriented framework—the Urban Water Adequacy for Development Index (UWADI)—which integrates water resource constraints into the early stages of spatial planning. Unlike conventional assessments based on observed consumption, UWADI relies exclusively on planned development parameters, enabling prior evaluation of whether proposed urban growth is compatible with available water resources. The index is defined on a scale from 0 to 1 and consists of four components: Adequacy Deficit (AD), representing the balance between planned demand and available supply; Seasonal Exposure (SE), capturing peak demand variability; Resource Vulnerability (RV), reflecting the robustness of water sources; and Phasing Mismatch (PM), addressing the temporal alignment between infrastructure provision and development. The framework is grounded in integrated planning principles and aligned with European policy directives, including the Water Framework Directive. A structured workflow links spatial planning parameters with water resource assessments, allowing development proposals to be classified according to water adequacy thresholds and associated planning constraints. The results demonstrate that incorporating water availability as a binding constraint significantly improves the robustness and feasibility of spatial plans. The proposed UWADI framework provides a transparent and scalable tool for bridging the gap between hydrology and spatial planning, supporting more resilient, sustainable, and evidence-based urban development under increasing water stress.

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ASSESSMENT OF PERMANENT DEFORMATION ON WARM MIX ASPHALT INCORPORATING ARAMIDE AND POLYMER-BASALT FIBRES

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ABSTRACT

The increasing traffic load and climate change effects, particularly higher temperatures, necessitate the development of more durable and resistant asphalt mixtures. This study evaluates the influence of dispersed reinforcement in the form of polymer-basalt and aramid fibers, bitumen type, and production technology on the high-temperature performance of asphalt concrete mixtures. The research focused on AC 11 mixtures produced using warm mix asphalt technology (WMA) with water-foamed bitumen, compared to conventional hot mix asphalt (HMA).

An experimental program was conducted to assess key physical and mechanical properties, including air void content, moisture and frost resistance (ITSR), rutting resistance and creep stiffness modulus. Various fiber types and contents, as well as different bitumen types (road bitumen and polymer-modified bitumens), were analyzed.

The results indicate that reducing production temperature by 30°C in WMA mixtures led to increased air void content and reduced resistance to water and frost compared to HMA mixtures. The addition of fibers generally increased air void content, particularly at higher fiber dosages. Mixtures with excessive fiber content did not meet standard requirements for durability parameters. However, moderate fiber contents (0.05–0.1% for aramid and 0.15–0.3% for polymer-basalt fibers) provided balanced performance.

In terms of high-temperature performance, mixtures with polymer-modified and highly modified bitumen showed improved resistance to permanent deformation and higher creep stiffness modulus. The best overall performance was observed for WMA mixtures containing moderate amounts of dispersed reinforcement, especially with polymer-modified binders. Among the analyzed mixtures produced at reduced temperatures, those reinforced with 0.05% aramid fibers and 0.15% polymer-basalt fibers exhibited the most favorable high-temperature properties, including enhanced resistance to permanent deformation and increased creep stiffness modulus, confirming their beneficial effect on this group of properties.

The study confirms that properly selected fiber type and content, combined with WMA technology, can enhance the high-temperature performance of asphalt mixtures while maintaining acceptable durability characteristics.

Corresponding Author: Anna Chomicz-Kowalska

ASSESSMENT OF THE IMPACT OF CHLORIDES AND FREEZE-THAW CYCLES ON THE REINFORCEMENT CORROSION PROCESS IN CONCRETE WITH BLAST-FURNACE SLAG CEMENT

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ABSTRACT

Over recent years, the construction sector has seen intensive development of concrete with a reduced carbon footprint, resulting from the need to reduce CO_2 emissions into the atmosphere. One of the solutions to reduce CO_2 emissions is the use of metallurgical cements in concrete, including CEM III cement, which contains granulated blast furnace slag. Changing the composition of the binder (despite the technological advantages and positive impact on ecology) may affect the level of durability of reinforced concrete structure elements operated in aggressive environmental conditions. The influence of the cement used on the change in the level of durability of reinforced concrete elements, understood as the development of corosion on steel reinforcement bars, results from the protective role of the concrete cover in relation to the reinforcement bars.

The article describes research aimed at assessing the impact of environmental factors such as the action of chloride ions and freezing and thawing cycles on the corosion rate of steel reinforcement bars in samples made of concrete based on CEM III cement containing granulated blast furnace slag. The corosion rate of the reinforcement was measured using the non-destructive, electrochemical galvanostatic pulse method. Additionally, selected physical and mechanical properties of concrete were tested, including compressive strength, water absorption, frost resistance and shrinkage.

The obtained results allowed for the assessment of the impact of environmental conditions on the corosion rate of steel reinforcement bars in concrete with blast-furnace slag cement and for the identification of environments most conducive to the initiation and development of corosion. The research carried out is only part of a broader research program carried out as part of the doctoral thesis, aimed at assessing the durability of reinforced concrete elements made of concrete with a reduced carbon footprint.

Corresponding Author: Wioletta Raczkiewicz

ASSESSMENT OF THE IMPACT RANGE OF A LIGHTWEIGHT DYNAMIC PLATE BASED ON DEFORMATION MEASUREMENTS WITH FBG FIBRE-OPTIC

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ABSTRACT

The LWD (Light Weight Deflectometer) dynamic plate is commonly used to assess the quality of pavement structural layers, particularly those made of unbound materials. It is very significant because it allows for quick measurements to be taken at multiple locations. An alternative method for testing soil and unbound mixture layers is the VSS static plate test. In contrast to the LWD method, this is a static test, slow and requiring the use of a counterweight appropriate to the load range. Receiving the results quickly enables an assessment of the quality of the layer under test and the formulation of recommendations regarding the subsequent compaction process. Despite the advantages of using LWD plate, a frequently asked question concerns the actual range of their impact, i.e. how deep the energy from the LWD plate impactor penetrates. Modern measurement methods enable the highly accurate recording of deformations internal to structural layers. In particularly, the advances in fiber-optic sensors methods enable recording of the strain distribution in the medium surrounding the sensor. In the case of dynamic testing, particular importance should be attached to FBG (Fibre Bragg Grating) sensors, which enable the recording of deformations at high frequencies.

This article presents the impact of varying surface loads on the recorded deformation values in the interior of a layer composed of unbound mix, used for base layers. The measurements were carried out on a laboratory model. The results of the tests enable an assessment of the depth of the impact energy typical for a lightweight LWD dynamic plate.

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A STATE-OF-THE-ART REVIEW OF SUSTAINABLE 3D-PRINTED CONCRETE INCORPORATING RECYCLED AGGREGATE

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ABSTRACT

Introduction: Three-dimensional concrete printing (3DCP) is increasingly recognized as a digital construction technology with the potential to reduce formwork demand, material waste, and labor intensity. In parallel, the growing volume of construction and demolition waste has increased interest in using recycled fine and coarse aggregates derived from waste concrete as sustainable alternatives to natural aggregates. However, incorporating recycled aggregates into 3DCP introduces distinct challenges related to fresh-state rheology, interlayer bonding, and direction-dependent mechanical performance.

Objectives: This state-of-the-art review evaluates sustainable 3D-printed concrete incorporating recycled aggregate, with particular emphasis on the relationships among material characteristics, printability, interlayer behavior, printing directionality in the X, Y, and Z axes, and structural performance.

Methods: Existing literature on recycled-aggregate 3DCP was critically synthesized with attention to fresh-state rheology and buildability, mechanical performance in different printing directions, interlayer-bond quality, material-treatment strategies, and sustainability-related implications.

Results: The reviewed studies indicate that recycled aggregates generally increase yield stress and thixotropy, which can improve buildability but may narrow the printability window because of higher water absorption and rapid structural build-up. In the hardened state, compressive and flexural strengths generally decrease, with the Z-direction being particularly vulnerable because weak interlayer interfaces can govern failure. Several strategies can partially recover mechanical performance, including admixture optimization, aggregate carbonation, or CO_2 pretreatment, fiber reinforcement, and interlayer-interlocking nozzle design. These approaches can improve interfacial transition-zone quality, crack-bridging capacity, and layer-to-layer performance.

Conclusion: The integration of recycled aggregate in 3DCP offers significant environmental promise, but achieving structural reliability requires coordinated control of mix design, interlayer adhesion, and printing parameters to ensure printability, mechanical integrity, and long-term sustainability. Key research needs remain in durability assessment, microstructural modeling, and data-driven optimization.

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A THREE-DIMENSIONAL DAM-BREAK FLOW, WET BED CASE: SHORT TIME BEHAVIOUR

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ABSTRACT

Initial stage of a three-dimensional, unsteady, gravity-driven flow caused by the sudden collapse of a vertical, circular cylindrical cavity in a fluid with a free surface is considered. The cavity extends from the free surface to a depth smaller than the total fluid depth. The fluid domain is divided into two regions: the exterior and interior regions. The interior fluid region is bounded and lies directly beneath the cylinder's bottom surface, while the exterior fluid region comprises the remaining unbounded domain. The resulting flow is described using potential theory. The Fourier series method is employed to solve the leading-order linear problem in both regions, and matching conditions are imposed at the interface, where the fluid pressures and radial velocities are equal. At the bottom circle of the interface, the leading-order flow velocity exhibits a power singularity of order as $r^{-1/3}$, where r is the radial distance from the intersection circle. Physically, this phenomenon is explained by the presence of a jet along the contact line, similar to that observed in the two-dimensional wet-bed dam-break problem involving two immiscible fluids. In the limiting case where the cavity radius and the origin both approach infinity, convergence to the two-dimensional problem is demonstrated. Three-dimensional effects become significant when the ratio of the cavity radius to its height is small. The theoretical analysis is supported by numerical results, which illustrate the free-surface evolution and jet formation. This paper aims to establish a connection between two- and three-dimensional dam-break problems. The study of dam-break problems is important due to their impact on the environment and human lives. The three-dimensional dam-break flows considered here are sometimes referred to as cavity-collapse flows. Underwater explosions can create cavities that collapse and generate jets at early times along the contact line between the cavity and the surrounding fluid.

Corresponding Author: Elona Fetahu

BETWEEN ATTACHMENT AND DEFICIENCY: RESIDENT AND SPECIALIST PERCEPTIONS OF A POST-SOCIALIST SUBURBAN NEIGHBORHOOD IN ORADEA, ROMANIA

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ABSTRACT

Post-socialist neighbourhoods across Eastern Europe bear the spatial and social imprint of decades of collectivist urban planning, when property ownership was suppressed. The transition to a market economy unleashed a long-demand and chaos regarding demand for private homes and urban planning laws and administration in Romania. Suburban developments reflected not only the economic aspiration of the inhabitants, but also a deeply rooted desire for individual space and autonomy. This study investigates the perception of residents (n=80) and urban planning specialists (n=4) regarding the Grigorescu neighbourhood in Oradea, Romania. Grigorescu neighbourhood was developed predominantly in the early 2000s, being a post-socialist suburban area, marked by uncontrolled residential growth and a significant lack of functional amenities. The research design follows a mixed-method survey approach. The study examines three dimensions: (i) residents' satisfaction with their neighbourhood, (ii) specialist assessment of urban planning instruments and public-private dialogue and (iii) residents' openness to land transfers and densification as part of a broader strategy for densification. The findings reveal a strong and consistent attachment to low-density living and "peace and quiet" attributes, functioning as the primary reason for choosing the neighbourhood and its most valuable characteristic. This attachment generated significant resistance to densification and building height increases, even as a trade for functional amenities in the area. On the other side, the specialists' perspectives and the current legislative framework – including the *General Urban Plan (PUG) and Urban Zonal Plans (PUZ)* – are not sufficiently assessed to support mixed-use development. Moreover, neither the administrative urban plans (PUG and PUZ) nor the national laws are equipped to establish a private-public exchange. Conflicting interests between public administration and private developers further hinder coordinated urban renewal. These findings suggest that any functional diversification strategy for Grigorescu must be grounded in transparent community engagement and low-density mixed-use solutions that do not compromise the residential area's character as a suburban low-density area.

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BETWEEN DATA AND SPATIAL JUSTICE: A PEDAGOGICAL LABORATORY FOR URBAN AND REGIONAL PLANNING EDUCATION

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ABSTRACT

The Executive Master in Smart Territories: Data and Decision Support Systems, recently proposed by ISMAT, emerges in a context where cities and regions face high complexity, data abundance, and increasing demands for transparency and efficiency in public decision making. In this scenario, it becomes crucial to explore how advanced training can position itself between the centrality of data and concerns with spatial justice in territorial governance.

The aim is to analyse the pedagogical model of the Master as a “laboratory” for experimenting with alternative forms of teaching in City and Regional Planning Education, describing the curricular choices adopted and the types of competences it seeks to develop. Methodologically, the work draws on an analysis of the curricular design and on the examination of a set of projects developed by students in collaboration with public entities and other territorial organisations, in fields such as mobility, land use, climate adaptation, and service provision.

Preliminary results indicate that the combination of courses on critical analysis of urban and regional transformations with modules focused on data infrastructures, modelling, and decision support systems promotes the development of technical competences (spatial analysis, indicator construction, use of multicriteria tools) and analytical skills, but also reflexive capacities to question assumptions, political priorities, and power asymmetries associated with data driven governance. By working on real world problems in a studio like format, students tend to recognise both the potential of data to improve decision making and the risks of making inequalities and local voices invisible.

It is concluded that the Master contributes to renewing education in urban and regional planning by positioning itself “between data and spatial justice”, systematically confronting data driven rationalities with concerns for equity, participation, and public accountability. It is argued that this experience can inform the redesign of other training programmes oriented towards smart territories, bringing advanced education closer to concrete decision making contexts.

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BEYOND FRAGMENTATION: A CONCEPTUAL TAXONOMY OF EXISTING METHODOLOGIES FOR A LAYERED ANALYSIS OF HISTORIC URBAN LANDSCAPE

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ABSTRACT

Urban analysis of historic cities faces a persistent methodological fragmentation. Existing approaches tend to operate within disciplinary fields, addressing either historical evolution, present spatial configuration, or cultural meaning, but rarely in an integrated manner. This paper proposes a taxonomy for the layered analysis of historic urban landscapes, and at the same time, it tests the validity of a conceptual framework developed around the proposed taxonomy. Conducting a systematic literature review, the taxonomy is structured around the 30 papers selected out of 169 retrieved. Scale of analysis was not included as exclusion criteria, resulting in a variety of case studies or approaches. Classifying the retrieved papers around the field of study, theory, ontological, epistemological and methodological roles, the taxonomy uncovers a structural order of analysis that links to the research questions and guides the scope of the urban analysis. While classifying the data, it became increasingly clear that largely, there are three sequences used in historic urban analysis: diachronic, synchronic and interpretative. The taxonomy guides towards a sequential approach that links the urban development (diachronic), analysis of the present city in relation (analytical) to the historical stages and cultural meaning and attributes of the built space (interpretative), addressing a structural problem in HUL methodology: the absence of a unified methodology for interpreting tangible and intangible layers.

The paper contributes by proposing a structural order that can be further developed into a framework. By systematically linking these stages – from historical development to present-day configurations and cultural meanings – this framework addresses a critical gap in urban studies, where traditional analysis often prioritises either quantitative spatial metrics or qualitative narratives, without a cohesive methodological bridge. Further research should test the applicability of the conceptual framework to a case study and also the inter-dependence of the proposed sequence: iterative, layered or strictly sequential.

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CHILDCARE IN TRANSIT: TRANSNATIONAL KINDERGARTEN NETWORKS BETWEEN EUROPE AND THE OTTOMAN EMPIRE

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ABSTRACT

Kindergarten institutions emerged not only as socio-educational initiatives but also as transnational reform projects that intersected with questions of gender and labor from the late nineteenth century onward, contributing to the redefinition of women's roles as socially productive and publicly recognized. In the Ottoman Empire, in the late nineteenth century, the kindergarten movement emerged through early childcare institutions known as *ırzahane*s, which were modeled on examples from Frankfurt (Germany), Genoa (Italy), Vidin (Bulgaria), and European factory-based crèches. Within the *ırzahane*s located in the *Darülaceze* (poor houses) complex in Istanbul, children were envisioned as being nurtured through a supportive female presence and cultivated within landscaped environments. Both spatial organizations of the Ottoman kindergartens and the feminist developments were the result of extensive transnational interaction. For instance, images of ırzahanes from the turn of the century indicate that these structures were integrated with nature, rapidly constructed—often using prefabricated elements—designed with large openings to maximize daylight and physically connected to larger complexes such as factories. [Fig 1] On the other hand, the *ırzahanes*, where childcare and nutrition were provided, spread across the major cities of the Ottoman Empire, and by the turn of the century female worker's children were being cared for in such institutions established in urban centers. This figure offers an approximate indication of the number of women engaged in paid work in that time.

With the onset of industrialization in the late eighteenth and early nineteenth centuries, women's entry into factory labor marked a departure from the domestic sphere and simultaneously gave rise to feminist movements. The children of working women were, in turn, entrusted to the compassionate care of other women who themselves were employed as caregivers or foster mothers. The Pestalozzi-Fröbel-Haus in Berlin was the earliest institution to provide women with formal academic education as kindergarten teachers, a highly progressive development in the late nineteenth century, when women's social roles were largely confined to marriage and domestic life (Murcia, 2019). In the decades following death of Friedrich Fröbel, a German educator and philosopher, in 1852, the kindergarten model expanded internationally, gaining widespread acceptance in countries such as the Netherlands, Italy, France, Switzerland, Great Britain, Japan—where the first kindergarten opened in 1876—as well as Canada and the United States. In 1874, Henriette Schrader-Breymann, Friedrich Fröbel's great-niece, established the Pestalozzi-Fröbel-Haus in Berlin as a pioneering socio-educational initiative. With the experimental practice of a *"people's kindergarten,"* Schrader-Breymann's aim was to integrate rigorous professional training for kindergarten teachers conceived as an educational environment accessible to children from all social backgrounds. From its inception, pedagogical instruction and hands-on practice were deliberately co-located to foster reciprocal learning and development. This study examines these late nineteenth-century Ottoman *ırzahane*s by focusing on their spatial organization and their approach to childhood, while also addressing the influence of contemporary feminist movements and transnational exchanges. As a methodological approach, Ottoman journals and booklets from the period will be examined in parallel with European sources.



Fig 1. Poor Children and their Kindergartens
Source: Servet-i Fünun, 534 (21) Author: *B.A, June 6, 1901*

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CHURCHES IN THE NATIONAL ROMANTIC STYLE: ANALYSIS OF ARCHITECTURAL COMPETITION DESIGNS IN POLISH LANDS BEFORE 1918

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ABSTRACT

The 19th and early 20th centuries were a period of the formation of modern national identities in Europe, based on linguistic, cultural, and historical commonality rather than solely on state affiliation. In the absence of independent statehood, many nations sought alternative means of expressing their distinctiveness. Artistic activity played a significant role in this process, with architecture, and particularly sacred architecture, serving as a key instrument in shaping national consciousness, owing to its wide accessibility and relative independence from political authorities. The 19th century witnessed intensive efforts to create national styles. Initially, these were sought within historical stylistic frameworks, in line with the dominant trend of historicism. However, toward the end of the century, there was a shift toward the development of new architectural forms, often stylistically related to Art Nouveau and aligned with the current of National Romanticism. As a result, in the Polish territories, among others, the Zakopane style and the so-called “familiar style” (*styl swojski*) emerged.

The article presents an analysis of designs submitted to four architectural competitions for churches held in Zagłoba (1906), Limanowa (1909), Orłów Murowany (1910), and Mąkoszyn (1911). The aim of the study is to identify and characterize the familiar style in sacred architecture in the Polish lands at the turn of the 19th and 20th centuries.

Based on the analysis and critical evaluation of sources, including archival competition designs as well as publications in architectural journals of the period containing their descriptions and assessments, the author conducted a comparative study of architectural solutions proposed by the designers, followed by their synthesis, in order to determine the stylistic features of the familiar style.

The analyzed designs represent an attempt to create architectural forms corresponding to the idea of the “Polish village” in a new interpretation. They constitute a creative reinterpretation of diverse historical and regional models, incorporating elements of Romanesque-Gothic, Renaissance, and Baroque traditions, as well as local wooden architecture, complemented by forms inspired by Art Nouveau. Characteristic features of these designs, such as compact massing, arcades, and the predominance of rustic forms, give them a vernacular and romantic expression, evoking the idea of the “national spirit.”

The results of the study allow the analyzed phenomenon to be classified as a manifestation of National Romanticism in sacred architecture, situated within the broader cultural processes taking place in Central Europe at the turn of the 19th and 20th centuries.

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CIRCULAR CONSTRUCTION ADOPTION IN TÜRKIYE: DEFINING CRITICAL BARRIERS FROM THE PERSPECTIVE OF CIVIL ENGINEERS

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ABSTRACT

Construction plays a central role in the global economy, contributing significantly to employment generation and economic growth, while also exerting substantial environmental pressures. Characterized by intensive resource consumption, substantial waste generation, and significant carbon emissions, it is a key driver of global sustainability challenges. In response, the circular economy (CE) has emerged as a strategic and transformative approach to enhancing the sustainability and resilience of the built environment. However, circular construction (CC) implementation remains constrained by complex, multi-dimensional barriers embedded in the sector, necessitating cross-functional perspectives that reflect its operational reality, particularly in developing countries such as Türkiye. Accordingly, this study identifies the critical barriers (CBs) hindering CC through the lens of civil engineers operating across diverse project phases and domains. A systematic literature review (SLR) identified 43 relevant studies, from which 58 barriers were extracted and categorized into four groups: (1) knowledge, technical competence, and infrastructure limitations (20 barriers); (2) awareness deficits, cultural resistance, and traditional sector dynamics (22 barriers); (3) institutionalization, governance, and strategic capacity deficiencies (10 barriers); (4) cost constraints, financing limitations, and economic uncertainty (6 barriers). A questionnaire based on these 58 barriers was developed using a 5-point Likert scale and administered to civil engineers in the Turkish construction sector. A total of 181 valid responses were analyzed using reliability analysis and normalized mean values (NMVs) to identify category-specific CBs. The findings indicate that 25 barriers are critical to CC implementation in the Turkish construction sector, with challenges predominantly concentrated in awareness deficits, cultural resistance, and traditional sector dynamics. These results provide a structured and context-sensitive understanding of CC implementation challenges and offer actionable insights for advancing a more sustainable built environment, while also informing similar efforts in developing countries with comparable construction sector dynamics.

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CITIZEN PERCEPTIONS OF URBAN GARDENING AND SUSTAINABLE DEVELOPMENT: A NEW ANALYTICAL FRAMEWORK

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ABSTRACT

Our study aimed to understand and explain citizens perspectives on urban gardening and sustainable development. We studied three second-tier cities in Poland and conducted 1086 surveys with citizens. The citizens' perspectives on urban gardening and the social, economic, and environmental dimensions of sustainable development were assessed using importance–performance analysis. Inferential statistics were used to explore the association between perception scores and gardening type. We found that citizens perceive the environmental aspects of urban gardening to be more important than the social and economic aspects from an overall sustainable development perspective. Higher sustainable development perception scores were observed among citizens who participated in multiple types of urban gardens. The study's findings highlight the development potential of the indicators of social connections, smart technology adaptation, and reductions in city operating costs. The results of gardening type on perception may be key to future decision-making.

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CLIMATE-RESILIENT SPATIAL ZONING FOR TEMPORARY CULTURAL INFRASTRUCTURES: A FRAMEWORK FOR FLOOD-PRONE CONTEXTS

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ABSTRACT

Event spaces and cultural areas are often built temporarily. These temporary structures are built without considering the possibility of defending against extreme weather events like floods. Under unforeseen situations like extreme weather, the accessibility and services will collapse. The impact on this will be particularly significant on the vulnerable population, mainly older adults and children. This study will develop a reproducible framework for creating these temporary cultural and event zones that withstand extreme weather events, using the open-source QGIS software. Buffer zones were delineated at distances of 15, 50, and 150 meters from the centre of the river line. The site is divided into three functional zones, based on accessibility, terrain conditions, and risk exposure within the buffer zone. Each zone is then strategically supported with multiple smaller systems spread across the site, nature-based solutions and certain other functions that can operate without disruption during extreme events. These facilities are designed to be close, accessible, and safe for all users, including older adults, people with physical disabilities, and children. The approach offers a low-cost, replicable strategy for climate resilience that can be integrated into temporary cultural and event spaces. This idea can be relevant to projects like Cirk Arena, especially for creating functional, flexible and safe event spaces that can run during extreme weather conditions.

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COMPREHENSIVE DIAGNOSTICS OF AN AERATED CONCRETE STRUCTURE: A CASE STUDY OF CRACK DEVELOPMENT

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ABSTRACT

The paper presents a case study of comprehensive diagnostics of a single-storey public facility building constructed from aerated concrete blocks, in which significant structural defects in the form of wall cracking and deformation of load-bearing elements were identified. The research aimed to determine the primary causes of these defects and to assess the interaction among the structural components of the building. The diagnostic investigation combined destructive and non-destructive methods, including visual inspection, destructive probes, core drilling, crack mapping, evaluation of roof structure based on determination of mechanical properties using Pilodyn, moisture measurement by resistivity hygrometer, and detailed analysis of structural details.

The results showed that the defects were primarily caused by a combination of inadequate roof truss design, insufficient compliance with construction procedures, and differential deformation of the materials used. A significant contribution also resulted from the rigid connection between steel structure of the shelter and the aerated concrete masonry without sufficient allowance for thermal dilation, leading to tensile stresses and subsequent crack propagation. The study confirmed the low resistance of aerated concrete masonry to tensile stresses and deformations induced by adjacent structural elements. In addition, the diagnostics revealed deficiencies in material quality and locally inappropriate construction detailing.

The case study highlights the importance of a comprehensive diagnostic approach in the assessment of aerated concrete structures and in the identification of defects that are typical of this type of building. Critical areas were found particularly at the interface between the external load-bearing masonry and the foundation structure, especially near door and window openings, as well as in zones affected by the interaction between the masonry, roof truss elements, horizontal structures, and attached extensions.

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COMPUTATIONALLY SMART DESIGN OF SOLAR PANEL INFRASTRUCTURES UNDER ENVIRONMENTAL LOADS FOR OPTIMAL ENERGY YIELD

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ABSTRACT

The increasing demand for efficient and sustainable energy solutions has accelerated the development of smart grid systems integrating advanced energy storage technologies. Among these, hydrogen storage is emerging as a promising solution for addressing the variability of renewable energy sources while improving grid stability and energy efficiency.

At the same time, the growing global demand for renewable energy requires the development of resilient solar infrastructures capable of maintaining performance under diverse environmental loads. Traditional design approaches often fail to account for structural and operational challenges caused by wind, snow, temperature variations, and seismic effects, leading to reduced energy yield and increased maintenance costs.
This study presents a computational framework for the design of solar panel infrastructures that integrates Finite Element Method (FEM) simulations with artificial intelligence (AI) and machine learning (ML) techniques. The proposed approach addresses two main aspects: structural optimization using FEM-based analysis and operational adaptation supported by sensor-based intelligent control systems. Environmental loads are systematically classified and their impact on system performance is evaluated.

To improve both structural reliability and energy efficiency, hybrid design strategies combining dynamic flexibility and structural reinforcement are considered. In addition, automation systems such as Supervisory Control and Data Acquisition (SCADA), Human-Machine Interfaces (HMI), and Programmable Logic Controllers (PLC) are integrated to enable real-time monitoring, control, and predictive maintenance.

The results indicate that the proposed approach can improve system performance and reliability compared to conventional design methods. The integration of computational modeling, intelligent control, and data-driven techniques provides a scalable solution for the development of robust and efficient solar infrastructures

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CONICAL ROOFS IN VERNACULAR ARCHITECTURE: TRANSFORMATION AND INTEGRATION INTO THE CULTURAL LANDSCAPE

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ABSTRACT

Vernacular architectures with conical roofs constitute distinctive morphological elements in rural landscapes associated with productive activities linked to agriculture, livestock farming, and water management. This study analyzes how these architectural typologies transform and integrate the cultural landscape across different territorial contexts, through a qualitative comparative approach applied to case studies in Portugal, Spain, and Peru. The methodology combined documentary review and fieldwork, allowing for the identification of variations in materiality, formal configuration, and strategies of territorial implantation. The results show that, despite employing diverse materials such as stone, wood, or earth, these constructions share an adaptive logic based on the use of local resources and responsiveness to environmental and productive constraints. The conical form thus emerges as an efficient constructive solution that, in addition to fulfilling practical functions, contributes to the visual structuring of the landscape and to the strengthening of territorial identity. In this sense, vernacular architecture is recognized as an active component in the cultural construction of the landscape, whose preservation is essential in the face of current processes of territorial transformation.

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CONSTRUCTION MATERIAL SUPPLY MODELS AND THEIR APPLICATION IN CONSTRUCTION COMPANIES OF DIFFERENT SIZES

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ABSTRACT

The organization of construction material supply plays a critical role in ensuring the continuity of construction activities, reducing delays, and improving overall project performance. Since construction projects are characterized by variability and fragmented supply chains, the selection of an appropriate supply strategy represents an important aspect of construction logistics management. This study aims to analyze construction material supply models and investigate their practical application in construction companies through a combination of literature review and empirical research. The study builds upon previous research examining the main construction material supply models, including direct delivery, warehouse-based supply, just-in-time (JIT) supply, and hybrid approaches, highlighting their characteristics, advantages, and limitations. To complement the findings of previous research with practical insights, a questionnaire survey was conducted among construction companies and craft enterprises operating in the Republic of Croatia. A total of 67 valid responses were collected and analyzed using descriptive statistical methods. The results indicate that material supply planning is predominantly based on a combination of several approaches and that hybrid supply models represent both the most frequently applied and the most reliable logistics solution. Delivery delays and insufficient storage space were identified as the most common supply-related problems, while early material ordering, alternative suppliers, and safety stocks constitute the main risk mitigation measures. Supplier reliability, delivery time, material quality, and long-term cooperation were recognized as the most important criteria in supplier selection. The findings further reveal that digitalization of supply management is mainly based on communication applications and spreadsheets, whereas advanced software solutions are less common. In addition, companies emphasize flexibility and adaptability as key characteristics of effective logistics systems.

The study confirms that no universally optimal material supply model exists and that effective logistics management depends on the ability to combine different supply approaches according to project requirements, material characteristics, supplier reliability, and operational constraints. The findings contribute to a better understanding of current practices in construction logistics and provide a basis for improving the efficiency and resilience of construction material supply systems.

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CORRELATION OF TEST LOAD RESULTS OF PILE FOUNDATION FOR VARIOUS SELECTED MODELS

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ABSTRACT

The purpose of this study is to analyse the foundation of an automated high-bay warehouse using Continuous Flight Auger (CFA) piles.

Data regarding the designed structure, geotechnical conditions, pile loads, and allowable differences in pile settlement were obtained from the detailed design, which included CPT probe tests, geological drilling, and laboratory tests of samples collected during drilling. This provided relatively precise data on the geological conditions in the area under consideration. The tests indicated that the area falls into geotechnical category II, and the ground conditions were considered as complex. Due to the presence of the soft soils, a foundation was designed using cast-in-situ CFA piles, which will meet the requirements for the first (ULS) and, above all, the second (SLS) limit state. The primary purpose of the designed piles is to ensure uniform settlement of the foundation slab on which the self-supporting racks of the planned warehouse are placed.

This study focused on determining the load-bearing capacity of piles using various calculation methods. The obtained results were compared with the values obtained from finite element method (FEM). The Midas GTS NX program was used. The results finally were compared with the pile load tests.

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CORVIN CASTLE: INTEGRATING 19TH-CENTURY RESTORATION INTO CONTEMPORARY PRESERVATION STRATEGIES

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ABSTRACT

Corvin Castle represents one of the most important medieval monuments in Central and Eastern Europe, reflecting Gothic, Renaissance, and Neo-Gothic interventions collected over several centuries. After a devastating fire in 1854, the castle became the focus of extensive restoration work that applied heritage conservation practices in the Austro-Hungarian context.

The present study investigates the evolution of restoration principles applied to Corvin Castle between 1854 and the early twentieth century, with a focus on the contributions of architects and scholars, such as Friedrich Schmidt, Ferenc Schulcz, Imre Steindl, and Istvan Moller. Moreover, the study investigates how the specific time documentation and conservation methodologies anticipate contemporary digital preservation strategies. The research methodology is based on archival investigation, comparative historical analysis, and heritage documentation review. Several sources were consulted, such as restoration reports, architectural drawings, old newspapers, and archival documents, in relation to current international digital preservation frameworks, including UNESCO guidelines.

The conclusions of the investigation demonstrate that the restoration work initiated after the 1854 fire marked a transition from improvised repair interventions towards scientifically grounded conservation practices. Moreover, the paper argues that the integration of historical archival documentation into digital preservation frameworks represents an important aspect in the process of sustainable conservation and management of cultural heritage sites. The Corvin Castle is not only a landmark of medieval architecture, but also a valuable case study for connecting traditional restoration methods with contemporary digital heritage practice.

In addition, the study shows that the castle's restoration history provides a clear example of how documentation, measurement, and material analysis can support long-term preservation decisions. This continuity between historical and digital approaches highlights the relevance of archival sources for present-day conservation planning. By combining historical evidence with digital tools, the research underlines the potential for more accurate, accessible, and sustainable heritage management.

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CRIPI: A EUROPEAN COLLABORATIVE FRAMEWORK FOR CLIMATE-RESILIENT PAVEMENT INFRASTRUCTURE

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ABSTRACT

Climate change significantly affects pavement performance, durability, and resilience, with broad consequences for safety, sustainability, and the reliability of transport systems. Understanding the ramifications of such changes in pavements requires a holistic approach integrating climatic stressors with materials, pavement systems, and construction practices to better understand and mitigate climate-induced deterioration. In response, CRIPI – the Climatic Resilience Initiative for Pavement Infrastructure – established as a four-year Action within the COST (European Cooperation in Science and Technology) framework, aims to address these challenges by establishing a multidisciplinary approach to advance knowledge on climate impacts, improve materials and design practices, and integrate innovative monitoring technologies to enhance the long-term resilience of pavement infrastructure. By bringing together diverse stakeholders, the initiative serves as a collaborative platform for knowledge exchange, promoting sustainable, climate-adaptive solutions and ensuring inclusive access to emerging technologies across Europe.

The main objectives of CRIPI are focused on two key areas: research coordination and capacity building. Within research coordination, CRIPI integrates fragmented knowledge into a coherent European network, advancing data-driven methodologies, resilience indices, and harmonized guidelines linking climate factors with pavement performance. In parallel, capacity building focuses on strengthening interdisciplinary collaboration, supporting early-career researchers, and promoting knowledge exchange through training and dissemination activities.

CRIPI, currently bringing together over 150 individuals from over 30 countries around the globe, is organized into six interconnected Working Groups (WGs). WG1 focuses on identifying climatic stressors, with the outcomes of its work being climate models, further linked to material performance (WG2) and pavement behaviour (WG3). WG4 integrates these findings through monitoring and modelling to develop resilience indices for future guidelines. Building on previous results, WG5 introduces an advanced sustainability assessment framework based on consequential LCA, while WG6 coordinates communication, dissemination, and networking activities, fostering collaboration and career growth of the Action members. In this context, the Young Researchers and Innovators (YRI) and the Resilient Pavement Association (RPA) initiatives provide targeted opportunities for PhD students and early-career researchers through active involvement in project activities and leadership roles.

The main deliverables of CRIPI include the development of harmonized methodologies, resilience indices, and stakeholder-oriented guidelines linking climate factors with pavement performance, supported by advanced modelling, monitoring, and sustainability assessment tools. These outcomes are complemented by open-access resources, a dedicated project website, training activities (such as workshops, seminars, summer and winter schools, and short-term scientific missions), and dissemination outputs, ensuring effective knowledge transfer and implementation across the European research and industry community.

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DAMAGES DIAGNOSIS IN MASONRY ELEMENTS BY NUMERICAL MEASURES OF VIBRATION PROCESS

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ABSTRACT

Building constructions as well as their elements must meet the requirements related to stability, rigidity, and strength. These are the conditions that determine the safety of the structure both during construction and operation. Safety assessment is based on diagnostic tests aimed at checking the quality of the erected objects or locating damage to structural elements that arose during operation. The work focuses on experimental SISO modal analysis of ceramic masonry elements. The experiment was carried out on forty samples of solid brick and perforated brick, of which half of were intentionally damaged, so that it was possible to determine the variability of the obtained measurement results of vibration characteristics resulting from damage to the masonry element, and thus to assess the usefulness of the method used in the given research problem.

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DECISION-MAKING IN THE RESTORATION OF HISTORIC WINDOWS: THE ROLE OF ENERGY EFFICIENCY IN HERITAGE PRACTICE

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ABSTRACT

Historic windows represent significant architectural, cultural, and material value, while also playing an important role in shaping the character of historic buildings. At present, however, they are often being replaced by modern structures due to increasing demands for energy efficiency and indoor thermal comfort. The restoration of historic windows therefore represents a complex issue in which it is necessary to seek a balance between preserving the authenticity of heritage-valued elements and meeting contemporary technical and energy requirements. This paper presents the results of a questionnaire survey focused on decision-making processes in the restoration of historic windows within heritage conservation practice. The questionnaire was addressed to experts from regional heritage offices in Slovakia, and its aim was to identify their attitudes toward the application of energy efficiency criteria in the methodological guidance of historic window restoration. The research focused primarily on whether, and to what extent, thermal performance aspects are considered relevant in decision-making on interventions in historic window structures. Special attention was given to the distinction between so-called “soft” and “hard” interventions in historic windows. Soft interventions mainly include maintenance, repair, sealing, or other reversible adjustments, whereas hard interventions include, for example, partial or complete replacement of structural elements, more substantial structural modifications, or the addition of an extra window layer. Within the survey, the degree of acceptance of the different types of interventions was analysed in relation to their potential impact on the material, structural, and stylistic authenticity, as well as the heritage value of the building. The results point to differences in regional approaches, as well as to varying degrees of consideration given to thermal performance and energy-related aspects in decision-making processes. Although the protection of material authenticity remains the dominant criterion, the results indicate a gradual increase in the importance of thermal comfort and energy performance issues, especially in the case of residential historic buildings. The survey findings provide valuable insight into current heritage conservation practice and form a basis for the formulation of methodological recommendations and the search for compromise solutions that respect heritage values as well as contemporary requirements for building use.

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DELAMINATION IN A MOVING MEMBER WITH AN ELECTRIC MOTOR ATTACHED TO IT

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ABSTRACT

The rapid development of technologies in construction is closely related to the use of modern construction mechanization. The members of various lifting machines, mechanisms, cranes and others perform various mechanical movements in the process of their work. In a number of cases, mechanical movement generates inertia loads, which have a significant influence on the carrying capacity, stability, safety and reliability of the members of the mechanization. Often, electric motors are attached to these members, which in the process of their work generate forced vibrations (for example, an unbalanced rotor acts with a harmonic force on the members, generating forced vibrations). The effect of these vibrations on the performance of the members is significant and, therefore, must be taken into account when analyzing various aspects of the behavior of the members, including their fracture. On the other hand, the introduction of modern engineering materials, such as multilayer ones, for the production of various movable members is one of the promising directions for the development of technologies in construction. This is the reason why in this paper the delamination of a multilayered horizontal member performing uniformly accelerated motion upwards is considered. An electric motor is attached to the member. This motor acts with a harmonic force in the direction of vibration of the member. The effect of these vibrations is taken into account when analyzing the delamination of the moving member. For this purpose, a solution for the strain energy release rate (SERR) in the member loaded with the corresponding inertia forces is obtained. The solution is verified using an approach for determining the SERR published in the scientific literature. Special attention is paid to studying the effect of the simultaneous action of the inertia forces from the movement of the member in the vertical direction and from the vibrations caused by the operation of the electric motor. Various graphs are presented illustrating the results of detailed parametric analyses of the SERR. This paper contributes to deepening the knowledge of the delamination behavior under dynamic effects.

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DESIGN HEATING LOAD VERSUS REAL UTILIZED HEATING POWER IN MULTIFAMILY BUILDINGS UNDER CHANGING CLIMATE CONDITIONS

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ABSTRACT

The sizing of heating systems in multifamily buildings is typically based on normative outdoor design temperatures and steady-state heat-load calculations. However, long-term climate change and the thermal modernization of existing buildings may increase the discrepancy between fixed design assumptions and operational heat use. This study evaluates design heating loads, design heat-loss structure, long-term heating degree days (HDD), and measured building-level heat delivery for a building stock located in northeastern Poland, within climatic zone V, where the normative outdoor design temperature is −24°C. The dataset comprises 23 multifamily residential buildings and one administrative building, which is reported separately. Building-specific calculations from Audytor OZC 6.9 were used to determine heated floor area, calculated seasonal heating demand, transmission heat loss, ventilation heat loss, and design space-heating load. Long-term HDD data from the Suwałki meteorological station were analyzed for the complete period 1951–2025. For the 23 residential buildings, the total heated floor area is 48,584.7 m² and the total design space-heating load is 2,233.7 kW. Individual loads range from 47.4 to 197.7 kW, while the area-weighted specific design load is 46.0 W/m². Ventilation accounts for 40.7% of the aggregate design load, with building-level shares ranging from 33.5% to 47.1%. The mean annual HDD decreased from 4,342.6 K·day in 1961–1990 to 3,953.7 K·day in 1991–2020, corresponding to a reduction of approximately 9.0%. The long-term linear trend for 1951–2025 is −109.2 HDD per decade. In 2022, annual HDD was 3,807.1 K·day, approximately 3.7% below the 1991–2020 mean. Measured 2022 heat-delivery data were additionally available for six residential buildings. These records combine space heating and domestic hot-water preparation and therefore are treated as operational energy indicators rather than as direct measurements of peak space-heating power. The results demonstrate that design capacity should be interpreted together with long-term climatic severity, the internal structure of heat losses, and the metering boundary of operational data before conclusions about real utilized heating power or system oversizing are drawn.

Corresponding Author: Mariusz Adamski

DETECTION AND SELECTIVE MEASUREMENT OF PEDESTRIAN, BICYCLE, AND MOTOR VEHICLE TRAFFIC USING A PUBLICLY AVAILABLE VIDEO STREAM: SYSTEM ARCHITECTURE AND VALIDATION

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ABSTRACT

Publicly available video streams can provide a complementary source of mobility data in locations where dedicated traffic-counting devices have not been installed. Their use, however, is more challenging than the analysis of recordings acquired under controlled conditions: the researcher has no control over camera placement or optical parameters, image quality varies with lighting and weather conditions, and objects may appear small, be partially occluded, or visually resemble static elements of the scene. Moreover, a high inference frequency of a deep-learning-based detector increases computational cost, whereas simple confidence-threshold filtering may lead to the accumulation of erroneous counts.The aim of this study is to present and validate a system architecture designed for event-based measurement of pedestrian, bicycle, and motor vehicle traffic using a continuous, publicly available MJPEG stream. The system integrates object detection from the YOLO family, geometric tracking based on KLT optical flow between successive detector inference steps, image-sector prioritization, mechanisms tailored to a fixed camera scene, and virtual counting gates. Importantly, the detection of a geometric crossing event is separated from the assessment of object reliability. Events are assigned one of three statuses: CONFIRMED, REQUIRES_REVIEW, or REJECTED. An uncertain event is recorded with a value of $\Delta = 0$ and does not increment the corresponding traffic count until subsequent verification has been completed. For each event, audit material is retained, comprising images captured before, at the moment of, and after the crossing of the virtual counting gate. The study presents the results of the technical validation of a selected development checkpoint, tests of counting-gate geometry, and an analysis of real-world cases collected during field sessions. Missing independent ground-truth data were not substituted with unit-test results; consequently, complete Precision, Recall, and F1 values for field-based traffic measurement remain to be determined in a separate validation experiment. The study also proposes a procedure for conducting such validation and defines the contribution of the system as the integration of resource-aware perception, location-specific suppression, and selective event counting within an auditable traffic-measurement pipeline.

Corresponding Author: Michał Bis

DETECTION AND ANALYSIS OF FORCE EFFECTS ACTING ON THE CLEATS OF PROFILED CONVEYOR BELTS USED IN ASPHALT MILLING MACHINES

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ABSTRACT

During renovation, construction and demolition work, large amounts of various construction waste are generated. Once the unsuitable or hazardous materials have been separated from the construction waste, the remaining mixture, known as construction debris, is usually crushed and sorted according to the size of the individual grains. When processing aggregate, which is widely used in the construction industry, crushing and screening methods are also used. Cold milling technology is used for road repairs, involving the removal of bonded layers using road milling machines. Most mobile machines designed for milling asphalt or concrete surfaces, crushing and sorting construction debris or aggregate are equipped with a belt conveyor fitted with a so-called profiled conveyor belt with cleats, which allows its longitudinal axis to be tilted relative to the horizontal plane within a range of up to approx. 40 deg. Profiled conveyor belts are also used in stable or relocatable belt conveyors where it is necessary to prevent the relative movement of the conveyed material grains, relative to the direction of movement of the conveyor belt, at conveyor inclination angles exceeding the limit inclination angle $\delta_k \approx 18$deg of conveyor belts of conventional design. Rubber cleats formed in special moulds during the production of the top cover layer of conveyor belts with textile skeleton, normally reach a height of up to 40 mm. Cleats are spaced at regular intervals along the entire length of the endless loop of the conveyor belt and are positioned at an angle α = 60 deg ÷ 90 deg to the longitudinal axis of the conveyor belt. The article presents the values of pressure forces obtained by measurements; the material transported - river gravel of grain size 4 mm ÷ 8 mm that act on cleat at inclination angles of the conveyor belt δ_1 = 18 deg ÷ 36 deg; for two different contact surfaces (plastic and rubber), which define the coefficient of shear friction f_{1i} [–], between the material grains and the working surface of the conveyor belt. Using profile conveyor belts, bulk materials can be conveyed at inclination angles up to approx. 40 deg, because a layer of material with a height of cleat is prevented from sliding down the surface of the conveyor belt provided that $f < \tan(\delta)$ [–] the coefficient of shear friction f [–] is less than the difference in the components of the forces acting on the material grains in the plane of the conveyor belt inclined at an angle δ [deg]. *The results are directly applicable to transportation engineering practice, particularly in the maintenance and rehabilitation of road infrastructure.*

Corresponding Author: Leopold Hrabovský

DETERMINATION OF THE RELATIONSHIP BETWEEN LATERAL RAIL WEAR ON A TRANSITION CURVE AND ITS CURVATURE USING GENERALIZED DYNAMICAL SYSTEMS

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ABSTRACT

Based on measurements, it has been shown that lateral rail wear on transition curves is characterized by significant irregularity. The presented tribological model of the wheel–rail system demonstrates the complex nature of rail wear phenomena. This tribological model constitutes a particular case of a generalized dynamic system with multiple inputs and outputs. In the case of transition curves, lateral rail wear is influenced by the curvature of the transition curve. Generalized dynamic systems will be employed to determine the relationship between the curvature of the transition curve and the corresponding lateral rail wear. Discrete measurements (taken at 1-meter intervals) of lateral rail wear on the transition curve will be used for system identification as a function of distance, taking into account the effect of curvature on rail wear. To avoid approximation of the measurement data, continuous dynamic systems were not used for this identification. Instead, discrete dynamic systems (without approximation of measurements) were applied, associated with difference equations described using the operator $S\{x_k\} = \{x_{k+1} - x_k\}$ in the space C(N) of real or complex sequences $\{x_k\}$.

The proposed method for identifying rail wear as a function of distance has shown that fifth-order difference equations, with an error smaller than 0.18 mm, describe the relationship between lateral rail wear on a transition curve and its curvature. The construction of the appropriate difference equation involved, among others, Hilbert spaces, the concept of linear independence and its properties, as well as the notion of identification error. To solve the obtained difference (recursive) equation, Heaviside operators corresponding to the operation T_q, which, among other properties, satisfies the condition $ST_q = id.$, were employed. It was also noted that the obtained difference equation can be solved (after appropriate transformations) using the operation $S_1\{x_k\} = \{x_{k+1}\}$, along with a suitable Heaviside operator or the $\mathcal{Z}$ -transform. The resulting relationship between lateral rail wear on a transition curve and its curvature may be applied in practice to prevent excessive rail wear and to extend rail service life.

Corresponding Author: Sławomir Grulkowski

DEVELOPMENT OF ALTERNATIVE REHABILITATION MORTARS WITH A LOW CARBON FOOTPRINT

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ABSTRACT

Currently, modern construction technologies and materials are confronted with the urgent challenge of fulfilling sustainable development goals. In accordance with global decarbonization strategies, the construction industry is intensively focused on the development of innovative materials, for which full functional compliance with conventional standards is required, while simultaneously minimizing negative environmental impacts. In this article, the results of a comprehensive experimental development of rehabilitation mortars intended for the remediation and reconstruction of masonry structures are presented. The primary contribution of the research lies in the application of an advanced low-emission binder system, by which carbon dioxide emissions generated during the production of primary raw materials are specifically reduced.

Within the framework of the conducted study, two mixtures of innovative rehabilitation mortars were designed and thoroughly optimized, utilizing alternative material bases for the partial substitution of Ordinary Portland cement. The proposed mixtures were subjected to a series of laboratory tests using standardized experimental methods. The monitoring was focused on key parameters of the mortars in the fresh state, such as consistency, air content and bulk density, as well as on the properties of the hardened composite. Specific focus was targeted to mechanical characteristics and the dynamics of strength development over time.

The obtained values of the tested properties for the new mixtures were subjected to a comparative analysis with the parameters of a reference mortar, which is a commercially available product. The evaluation also included the quantification of environmental impacts through the Life Cycle Assessment (LCA) methodology, which allowed for an objective comparison of the ecological footprint of the developed mixtures against the reference sample. The results of the experiment demonstrated that the innovated mortars exhibit comparable functional properties relative to the commercially available standard. Simultaneously, it was confirmed that the applied binder system leads to more favourable environmental parameters across the monitored impact categories. The presented study thus confirms the potential of low-emission binders to produce technically effective and environmentally friendly construction materials, fully meeting current demands for sustainable construction.

Corresponding Author: Adéla Valentová

DIGITAL RECONSTRUCTION OF FORMER MUNICIPAL BUILDING/MARONITE YUSUF ŞAR MANSION: ARCHITECTURAL TRANSFORMATION OF A HISTORICAL HOUSE

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ABSTRACT

Konya, as one of the significant cities of Anatolia with its multi-layered historical development, hosts architectural heritage from various periods. The Mevlana axis, in particular, constitutes an important urban spine that reflects the continuity between traditional and modern architecture. Located along this axis, the former Konya Municipal Building—currently functioning as a branch of İş Bankası—represents a noteworthy case for understanding the architectural transformation of the city.

The aim of this study is to examine the functional and spatial transformation of the building originally constructed as the Maronite Yusuf Şar Mansion. It seeks to reveal how the architectural identity evolved through its transition from a residential mansion to a municipal building and later into a bank, as well as to evaluate the reflections of this transformation within the urban context.

The study is based on archival documents, literature review, and historical photographs. Due to the absence of original architectural drawings, restitution analyses were conducted using photo match technic based on archival visuals and comparable period structures. Additionally, the plan scheme, façade organization, material usage, and construction techniques were comparatively analyzed.

The findings indicate that the building initially featured a traditional inner-hall (sofa-centered) plan typology characteristic of Konya's residential architecture, while also incorporating Western influences. During its second phase as a municipal building, functional modifications were made to the interior spaces. Following its demolition, the modern municipal building constructed on the same plot reflected the architectural tendencies of its period through a reinforced concrete system, simplified mass composition, and functional planning approach. This transformation process exemplifies the transition from traditional architecture to modern public buildings in Konya.

The transformation from the Yusuf Şar Mansion signifies not only a change at the building scale but also substantial shifts in urban and cultural memory. The loss of the original traditional structure raises critical debates regarding conservation policies, while the modern structure that replaced it represents the architectural values of its own period. This study highlights the importance of evaluating architectural layers from different periods together in order to develop sustainable conservation approaches.

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EFFECTIVE RENOVATIONS OF MULTI-STORY STUDENT DORMITORIES WITH ENVELOPE-INTEGRATED PHOTOVOLTAIC INSTALLATIONS

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ABSTRACT

The paper concerns the energy renovation of buildings carried out through the installation of photovoltaic systems integrated into building envelopes, including both façades and roofs. The main objective of the study is to present a method enabling effective modernization of high-rise student dormitories through a parametric analysis of the geometric and energetic characteristics of building-integrated photovoltaic (BIPV) systems. For this purpose, a comparative analysis was conducted with the help of parameters defining the energy performance, electricity production, and economic aspects of the investigated photovoltaic installations. The issues discussed constitute a continuation of the results obtained in two previous research projects involving separate groups of simulations modelling energy renovations of buildings using photovoltaic systems arranged on façades and roofs. The performed analysis was based on the innovative models optimized with respect to their energy performance shaped during several innovative computer simulations. For the renovated buildings two groups of optimized configurations of photovoltaic installations were selected. In addition, the measurable characteristics and discrete values within the predicted ranges of independent variables were predefined. The first group concerns the optimized photovoltaic systems integrated into building façades, while the second group relates to the optimized photovoltaic systems integrated into roofs. The research methodology is based on the main assumption of a specific value of the grid-energy substitution by the electricity generated by photovoltaic systems. Subsequently, the dependence between the discrete input parameters (independent variables) and the parameters defining the effective energy performance of the installations was analysed. The obtained results indicate that, for identical grid-energy substitutions (equality of the arbitrary replacement rates), façade-integrated photovoltaic systems require ~~a~~ smaller occupied areas than roof-mounted systems. Similarly, the total surface area of façade-integrated installations is also smaller roof-integrated ones providing the same boundary conditions. Economic aspects of the proposed modernizations were also considered. The obtained results demonstrate that a number of the examined roof-integrated photovoltaic systems are characterized by lower costs and shorter payback periods than the façade-integrated systems. However, several roof-built configurations may also exhibit higher costs and longer payback periods compared with the façade-integrated installations. The obtained results, including the method, can be applied in the search for optimal solutions in civil engineering through photovoltaic installations whose electricity production effectively replaces a significant share of the grid-supplied energy. The proposed innovative qualitative and quantitative models, including input models (defined by means of the independent variables) and output models (created with the help of the dependent variables) may also be employed in various civil-engineering parametric methods of building renovations.

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EFFECT OF CURING SEQUENCE ON THE 28-DAY COMPRESSIVE STRENGTH OF WATERBORNE EPOXY-MODIFIED CEMENT MORTAR

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ABSTRACT

Polymer-cement composites are an important group of materials used in construction, particularly in applications requiring improved tightness, durability, and resistance to aggressive environmental conditions. One possible direction for modifying cement mortars is the use of waterborne epoxy resins. However, such systems are more complex than traditional cement mortars, as their properties may depend not only on the mixture composition but also on the curing conditions applied after specimen preparation.

The aim of this study was to evaluate the influence of selected curing conditions on the 28-day compressive strength of cement mortars modified with waterborne epoxy resin. As part of the experimental program, mortar series containing a two-component epoxy system were prepared and subjected to different curing regimes. The investigated variants included curing in water, curing under air-dry conditions, combined curing regimes, and short-term thermal treatment. After the curing period, compressive strength tests were carried out, and the obtained results were compared in order to assess the influence of the applied curing scenarios.

The analysis showed that the curing method may significantly differentiate the final mechanical properties of polymer-cement composites. Particular importance was observed for curing variants combining different environmental conditions during the maturation period. This confirms that curing should be treated as an important technological factor in the design of cement mortars containing waterborne epoxy resin.

The study is experimental in nature and aims to systematize the influence of curing conditions on the properties of polymer-cement mortars. The obtained results may be useful for further development of this type of composite, especially in applications where durability, tightness, and stability of mechanical properties are of particular importance.

Corresponding Author: Ireneusz Laks

EFFECT OF LABORATORY AGING ON THE PROPERTIES OF RECLAIMED ASPHALT MATERIALS RECOVERED FROM EXISTING ROAD PAVEMENTS AND PREPARED IN THE LABORATORY

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ABSTRACT

The increasing use of reclaimed asphalt pavement in hot recycling requires reliable methods for assessing aged materials and their response to additional thermal conditioning. One relevant need is to develop laboratory procedures for producing synthetic reclaimed asphalt with properties comparable to materials recovered from existing pavements. This study evaluated the effect of laboratory aging on field and synthetic reclaimed asphalt materials and aimed to assess changes in their properties as a function of aging duration. Four reclaimed asphalt materials were analyzed: field-recovered reclaimed asphalt containing paving-grade bitumen, field-recovered reclaimed asphalt containing polymer-modified bitumen, laboratory-prepared synthetic reclaimed asphalt containing paving-grade bitumen, and laboratory-prepared synthetic reclaimed asphalt containing polymer-modified bitumen. The investigated reclaimed asphalt materials and the binders recovered from them were evaluated after five laboratory aging periods: 0, 3, 6, 9, and 12 days. The testing program included mechanical characterization of compacted reclaimed asphalt specimens and characterization of the recovered binders. Mechanical properties were determined by indirect tensile testing, including the cracking tolerance index, CT Index, and indirect tensile strength. The binders were characterized using needle penetration, ring-and-ball softening point, dynamic shear rheometry, and Fourier-transform infrared spectroscopy, including carbonyl and sulfoxide indices. The laboratory-prepared material containing paving-grade bitumen reproduced the main aging-related tendencies observed for the corresponding field-recovered material, including changes in consistency, rheological stiffness, and oxidation-related FTIR indices. The synthetic material containing polymer-modified bitumen showed partial agreement with the corresponding field-recovered material, indicating that the representativeness of laboratory aging depended on binder type and evaluated property. Correlation analysis showed that CT Index was positively associated with penetration and negatively associated with rheological stiffness parameters and oxidation-related FTIR indices, particularly the sulfoxide index. The findings indicate that the adopted laboratory aging approach enables comparison of field and synthetic reclaimed asphalt materials and supports the assessment of aging-related changes in both the recovered binder and the mechanical response of compacted reclaimed asphalt specimens. The approach reproduced selected aging-related trends observed in field-recovered materials, particularly for paving-grade bitumen, and provides a basis for further refinement of laboratory procedures for producing synthetic reclaimed asphalt representative of field reclaimed asphalt.

Corresponding Author: Justyna Stępień

EFFECT OF RECYCLED AGGREGATE CONTENT ON THE LONG-TERM MECHANICAL AND DURABILITY CHARACTERISTICS OF FLY ASH-BLENDED CONCRETE

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ABSTRACT

Concrete mixtures were prepared using a blended binder comprising 20 wt.% Class-F fly ash and 80 wt.% Portland cement, with natural aggregates partially replaced by recycled aggregates (RA) at varying proportions. This study aims to evaluate the combined influence of fly ash incorporation and recycled aggregate content on the fresh, mechanical, and durability performance of sustainable concrete. Fresh-state properties were assessed through slump and wet density measurements, while long-term hardened-state performance was evaluated using compressive strength, split tensile strength, and abrasion resistance tests. Moisture sorption behavior and microstructural characteristics were further examined using sorptivity analysis and scanning electron microscopy (SEM).

The results indicate that increasing RA content reduces workability and fresh concrete density due to the higher water absorption and rough surface texture of recycled aggregates. In the hardened state, higher RA levels adversely affected both mechanical and durability performance. At 90 days, compressive strength decreased by 17% and 21% for 50% and 100% RA replacement levels, respectively, while split tensile strength declined by 13% and 17%. Abrasion resistance also deteriorated significantly, with mass loss increasing by 54% and 68% for 50% and 100% RA incorporation, respectively. Similarly, moisture sorption increased by 27% and 54%, indicating higher permeability with increasing RA content.

These trends are primarily attributed to the higher porosity, residual mortar content, and weaker interfacial transition zones associated with recycled aggregates. Microstructural analysis confirmed increased heterogeneity in recycled aggregate concrete mixtures with higher RA levels. However, the inclusion of fly ash contributed to improved long-term performance by refining the pore structure and partially mitigating the adverse effects of RA.

Overall, the findings highlight the trade-offs associated with recycled aggregate utilization and demonstrate the potential of fly ash in developing durable and sustainable concrete mixtures.

Corresponding Author: Roz-Ud-Din Nassar

EFFICIENCY OF DEMOLITION TECHNOLOGIES IN THE CONTEXT OF A CIRCULAR ECONOMY IN CONSTRUCTION

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ABSTRACT

The AEC industry (Architecture, Engineering, and Construction) is one of the industries that can implement the principles of the circular economy to a high degree. The essence of the circular economy, as part of sustainable construction, is based on Reduce, Reuse, and Recycle (3R) of construction and demolition waste (CDW). Although, in all phases of the life cycle of buildings, it is possible to influence the generation of construction and demolition waste, the largest volume of waste is generated during the demolition of buildings. The choice of demolition technology significantly affects the efficiency and success of the implementation of the 3R principles of the circular economy. Their implementation is not only possible, but also desirable. On the second hand, it requires a comprehensive approach from consistent planning and selective waste sorting to the active involvement of recycling mechanisms. Currently, the manual demolition, mechanical demolition and building implosion he are mainly used technologies for constructions demolition; and robotic systems are understood as emerging technologies.

The aim of the paper is to determine the efficiency of the demolition technology of the selected building in the context of the circular economy. The research is carried out through a case study, where variants of demolition technology and the method of the generated construction and demolition waste disposal are proposed. The paper analyses the economic and ecological aspects of the proposed variants, which are associated with the costs of demolition work and the generated waste disposal. At the same time, the carbon footprint of both variants, which arises during transport processes related to the generated construction and demolition waste management, is also addressed. The selection of an effective variant solution is determined through multi-criteria decision-making method.

Corresponding Author: Marcela Spišaková

ENERGY PERFORMANCE IMPROVEMENT OF AN EXISTING OFFICE BUILDING USING DYNAMIC SIMULATION AND FUTURE CLIMATE SCENARIOS: A CASE STUDY IN KRAKÓW

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ABSTRACT

Buildings constructed in the early 21st century often do not meet current energy efficiency requirements. This applies in particular to primary energy consumption and system efficiency. Retrofitting existing buildings to current standards is often not mandatory. Nevertheless, adapting them is crucial for improving the resilience of the building sector to climate change.

The aim of this study is to assess the potential to approach the nearly Zero-Energy Building (NZEB) standard in an existing office building located in Kraków, Poland. The analysed retrofit options are evaluated under both current and future climate conditions. The case study building was commissioned in 2010 and has a total usable floor area of 5701 m².

The methodology is based on the development of a dynamic simulation model using EnergyPlus software. The model is calibrated and validated using data on energy consumption for heating and cooling from 2024. It is then used to simulate hourly energy demand for the analysed variants. The investment costs of the proposed measures are also estimated.

Several retrofit options are considered. These include improvements to the building envelope, upgrades to technical systems, and the use of renewable energy sources. Simulations are performed for the developed strategies using future climate data based on the RCP4.5 and RCP8.5 scenarios. The long-term performance and resilience of the building are assessed.

The results indicate a substantial reduction in primary energy demand and operating costs. The analysis also shows a change in energy demand patterns. Heating demand is expected to decrease, while cooling demand is expected to increase under future climate conditions. Although different retrofit strategies can approach the NZEB standard, their long-term performance varies. An integrated approach can provide substantial energy savings and reduce the risk of overheating. This observation is consistent with trends reported in similar studies on building performance under changing climate conditions.

The results demonstrate the importance of combining energy retrofit measures with climate adaptation strategies. It also confirms that dynamic simulation tools can support decision-making in the retrofit of existing buildings, particularly in the selection of retrofit strategies under changing climate conditions.

Corresponding Author: Aleksandra Sufa

ERTMS LEVEL 2 IMPLEMENTATION ON A REGIONAL RAILWAY LINE: AN ITALIAN CASE STUDY

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ABSTRACT

Advancements in railway signalling and train control technologies have significantly contributed to improving operational safety, service reliability, and infrastructure utilization within contemporary railway networks. In this context, the European Rail Traffic Management System (ERTMS) represents the main initiative aimed at standardizing railway signalling and enabling interoperability among national rail systems. By integrating the European Train Control System (ETCS) with digital railway communication technologies, ERTMS supports more efficient traffic management and higher operational safety levels. Although the system has been extensively implemented on high-speed lines and strategic freight corridors, its application to regional railway networks characterized by simpler infrastructure and limited signalling equipment has received comparatively less attention.

To assess the actual performance benefits of this system in secondary operational contexts - characterized by low speeds and limited traffic demand - this paper investigates the potential implementation of an ERTMS Level 2 (ERTMS L2) signalling architecture on a regional single-track railway line in central Italy. The analysis focuses on the Lanciano–San Vito Chietino railway line in the Abruzzo region, which currently operates under restrictive conditions due to the lack of an advanced signalling and train protection system. Consequently, operational regulations impose strict limits on train speed and service frequency, resulting in reduced operational and the Radio Block Centre (RBC). The block layout and associated speed constraints are defined according to operational and safety requirements, while radio communication continuity is ensured through the strategic positioning of GSM-R antennas connected by a redundant fibre-optic network.

To evaluate the potential benefits of the proposed system, the current operational scenario is compared with a theoretical scenario in which ERTMS L2 is fully implemented. The analysis indicates that travel time could be reduced by approximately one third, corresponding to a cumulative annual saving of about 108,000 hours at current demand levels, with notable socio-economic benefits. Additionally, the upgraded signalling system could increase service frequency by nearly 190%.

The results suggest that the introduction of ERTMS L2 on regional railway infrastructure can generate relevant improvements in operational performance, service capacity, and safety conditions. Furthermore, the study highlights the importance of adopting advanced signalling solutions as a strategy to enhance the efficiency and competitiveness of secondary railway lines within regional transport systems.

Corresponding Author: Gino D'Ovidio

EXACT SOLUTIONS OF DOUBLY REINFORCED CONCRETE SECTIONS WITH PRE-DEFINED COMPRESSION STEEL RATIO

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ABSTRACT

In designing buildings In high seismic regions, some building codes require the positive and negative moments strength shall fulfill a certain capacity ratio. For example, some building codes require the positive moment strength at joint faces shall be at least one-half the negative moment strength. Generally, the design process is done by considering the beam as a singly reinforced section; and no closed-form solution is available in the literature. In this case, the area of the steel is designed by considering either the negative or positive moment, successively, as a singly reinforced section. In this paper, closed-form solutions are derived by defining the ratio of compression to the tension steel. This ratio is defined as the positive to negative moment strength ratio. Closed-form solutions are derived to design reinforced concrete beams with this pre-defined ratio of compression to tension steel. The resulting closed-form solutions are in the form of cubic and quadratic equations. If the compression steel yields, we can obtain the quadratic equation. On the other hand, for the case of compression steel does not yield, the solution turns to be a cubic equation. Some examples are presented to implement the resulting equations. To verify the design equations, some compression steel ratios are plotted against the moment capacity. The results show that by assigning a certain value of the compression steel ratio, the resulting moment capacity will achieve at least a minimum requirement as stipulated in the building codes

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EXPERIMENTAL ASSESSMENT OF HUMAN COMFORT UNDER ENVIRONMENTAL VIBRATIONS: A CASE STUDY IN A RESIDENTIAL BUILDING

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ABSTRACT

Providing safe, healthy and comfortable indoor environments has become one of the principal objectives of contemporary civil engineering and sustainable urban development. Rapid urbanisation has substantially changed the environment in which residential buildings operate. Increasing transportation demand, continuous infrastructure development, and urban densification have brought buildings closer to roads, railways, and construction activities, resulting in more frequent exposure to environmental dynamic loading. Environmental vibrations generated by transportation systems, construction activities, and industrial operations are among the most common dynamic actions affecting residential buildings in urban environments. The transmission of vibrations from the source to the building is influenced by multiple factors, including the vibration source characteristics, propagation through the soil, foundation conditions, and the dynamic properties of the building itself. Consequently, the vibration response perceived by occupants is governed by the combined behaviour of the source–soil–structure system rather than by the excitation source alone. To address these challenges, this study presents an integrated experimental–numerical framework for the assessment of environmental vibrations in a residential building subjected to transportation- and construction-related dynamic loading. The proposed framework combines in-situ vibration measurements with finite element modelling under real operating conditions and complemented by finite element modelling to facilitate the interpretation of measured vibration responses and to evaluate the dynamic behaviour of the building. The presented methodology extends conventional vibration assessment based solely on standardised vibration descriptors by integrating experimental observations with structural dynamic modelling. Such an approach improves the understanding of vibration propagation through building structures and provides a reliable basis for evaluating existing buildings, verifying numerical models and supporting the design of mitigation measures in locations affected by transportation- and construction-induced vibrations.

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EXPERIMENTAL INVESTIGATION OF GEOPOLYMER AS A SUSTAINABLE ALTERNATIVE TO CONCRETE IN REHABILITATION OF TUNNEL LININGS

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ABSTRACT

This study evaluates a fiber-reinforced geopolymer concrete as a durable, low-carbon alternative to Portland-cement concrete for tunnel lining rehabilitation. Four high-performance mixtures, combining two aluminosilicate precursors, industrial by-products, alkali-resistant glass fibres and granite aggregates, were cast as cubes and prisms and cured for 7 and 28 days under air, semi-humid and water-immersion conditions. Compressive and flexural strengths were measured in accordance with EN 196-1. The best mixes (MD2 and MD4) reached cube strengths of 75–76 MPa and prism strengths of about 80–85 MPa, with flexural strengths up to 12.3 MPa. Water-cured specimens achieved compressive strengths simi-lar to, or slightly higher than, semi-humid specimens, indicating that ex-ternal moisture cannot damage geopolymerisation rather than degrade the material. Overall, the proposed mixes meet the mechanical requirements for precast tunnel-lining segments and appear well suited for durable re-habilitation in humid, water-rich environments.

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EXPERIMENTAL INVESTIGATION OF LOAD–DEFORMATION BEHAVIOUR OF DOWEL-TYPE SIMULATED L-SHAPE TIMBER CONNECTIONS IN CONTEXT WITH SECOND GENERATION EUROCODE 5 PROVISIONS

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ABSTRACT

Investigation of deformation development of dowel-type moment resisting connections are important when they are used in knee joints of timber portal frames, where excessive joint deformation may significantly reduce the global stiffness and serviceability of the structure. The test setup for investigation of the load–deformation response is mechanical analogous to a knee joint of a timber portal frame, where the middle and side timber members have different grain orientations and therefore deform differently under load. The experimental programme consists of three specimen series. Serie 1 consists of small-scale softwood connection model with S235 steel rods providing that board thickness and rod diameter ratio varies 5-8 for side boards and 14-19 of middle board. After static load test, every specimen was cut through the dowel area for visual evaluation of dowel bending form, embedment deformation and the effective contact zone between the dowel and wood. Specimen series 2 consisted of three steel-to-timber connections (steel plates 3x20mm on both sides and all three boards of 66 mm thickness, board thickness to plate thickness ratio - 22. Development of deformations were recorded using the digital image correlation (DIC) method. Specimen series 3 consists of large-scale timber connections with 35 mm diameter oak dowels and 35 mm steel dowels, boards 35 mm side and 70 mm middle (ratio t/d of 1 and 2), allowing the influence of fastener material on connection flexibility to be evaluated. Experimentally obtained results have been compared with the theoretical values calculated according to the draft of the second generation of Eurocode 5 (prEN 1995-1-1:2023). The results show that the load–deformation response of the connections is approximately linear only up to about 30–35% of the connection theoretical load-bearing capacity. At approximately 50% of the load-bearing capacity, the effective contact thickness between the dowel and timber remained about 85–95%, while at the ultimate load-bearing level only about 60–65% of the board thickness was in full contact with the dowel. Large-scale connections with oak dowels reached connection slip of 1.2–2.0 mm at the 50% load level, whereas connections with metal dowels showed slip of only 0.5–1.0 mm at the same load level. The results indicate that fastener shape, loading direction and dowel elastic properties have a significant influence on connection flexibility.

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EXPERIMENTAL INVESTIGATION OF MASS DISTRIBUTION EFFECTS ON THE DYNAMIC BEHAVIOUR OF MULTI-STOREY BUILDINGS

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ABSTRACT

The paper presents an analysis of the dynamic response of a multi-storey building subjected to paraseismic (mining) excitation using a shaking table. The main objective of the study was to evaluate the influence of mass distribution along the height of the structure on its dynamic response. Particular attention was paid to the role of additional mass associated with non-structural elements and operational loads, which in real buildings may significantly modify the dynamic characteristics of the structure. In the experimental model, the additional mass represented non-structural components such as partition walls, finishing elements, as well as permanent and live loads typically present during building operation.

The analysis was based on the a series of shaking table experiments. The laboratory model represented a multi-storey frame–slab building structure designed to reproduce the global dynamic behaviour of a real building. The model was instrumented with accelerometers installed at selected floor levels in order to record the structural response during dynamic excitation. The structure was subjected to one-directional kinematic excitation generated by the shaking table. As the input motion, a recorded real paraseismic ground motion was applied, which allowed the experimental conditions to reflect realistic mining loading.

To investigate the influence of mass distribution along the height of the structure, several configurations of the model were considered. These included a reference model without additional mass, a model with uniformly distributed mass applied to all storeys, and models with non-uniform mass distribution along the building height. Such configurations were intended to represent different practical scenarios related to the arrangement of non-structural elements and variations in operational loading within the building. For each configuration, the basic dynamic characteristics of the structure were determined, including the natural frequencies of vibration. Subsequently, the dynamic response of the model to mining excitation was analysed.

The structural response was evaluated primarily on the basis of acceleration records obtained from the floors of the model. A comparative analysis of the measured responses for the considered variants was then performed. The obtained results indicate a clear influence of the mass distribution on the dynamic properties of the structure, including changes in natural frequencies and variations in the amplitude of floor accelerations.

The study demonstrates that the vertical distribution of mass in a building, resulting for example from the arrangement of partition walls, functional use of rooms, or changes in operational loads, may significantly affect the dynamic response of the structure under paraseismic excitation. These conclusions highlight the importance of considering realistic mass distribution when analysing and modelling the paraseismic behaviour of building structures.

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EXPERIMENTAL INVESTIGATION OF POST-FIRE MECHANICAL BEHAVIOUR OF STRUCTURAL STEEL S235JR SUBJECTED TO FIRE LOADING AND DIFFERENT COOLING METHODS

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ABSTRACT

Fire is one of the most severe accidental actions affecting building structures, and steel elements exposed to high temperatures may retain load-bearing capacity even after the fire has been extinguished. Since visual inspection alone is insufficient to assess the safety of fire-damaged steel elements, reliable knowledge of their post-fire mechanical behaviour, including both the mechanical properties and the shape of the stress-strain response, is essential for structural diagnosis.

The aim of this study was to experimentally investigate the post-fire mechanical behaviour of structural steel S235JR after fire loading, and to evaluate how the maximum temperature reached and the subsequent cooling method affect the resulting stress-strain diagrams as well as the residual yield strength, tensile strength, modulus of elasticity, and ductility of the material.

A total of 45 standard tensile test specimens made of S235JR steel (five per group) were heated to nominal temperatures of 500 °C, 600 °C, 700 °C, and 800 °C, with the heating regime approximating the ISO 834 fire curve. For specimens heated to 800 °C, an additional 30-minute holding period was applied to allow the austenitizing transformation, which begins at approximately 723 °C, to approach completion before cooling. One series at each temperature was cooled rapidly by water quenching, and a second series slowly in an isothermal chamber. A reference series was tested at 20 °C without thermal loading. Residual yield strength (R_e), tensile strength (R_m) and elongation (A) were determined from the stress-strain diagrams and compared between groups using Welch's t-test, one-way ANOVA, and linear regression against temperature.

Reference specimens showed R_e = 282.9 MPa, R_m = 420.8 MPa and A = 36.6%. Up to 700 °C, R_e and A remained close to reference values for both cooling methods (R_e 283–296 MPa, A 35–37%), with no significant effect of cooling method ($p > 0.05$), while Rm was already significantly higher after water quenching than after slow cooling ($p < 0.05$). At 800 °C, all properties diverged significantly between the two methods ($p < 0.05$): slow cooling reduced Re to 253.9 MPa (90% of reference) and increased A to 41.6% (113%), fully meeting EN 10025-2 requirements, whereas water quenching raised Rm to 514.5 MPa, exceeding the standard range for S235JR, while A collapsed to 17.9% (49% of reference), below the required minimum of 26%. In all five water-quenched 800 °C specimens the distinct yield plateau disappeared, with yield strength evaluated as offset $R_{p0.2}$ instead of R_{eH}.

Up to 700 °C, residual yield strength and ductility of S235JR are governed mainly by temperature, largely independent of cooling method, while tensile strength is already measurably cooling-sensitive. Above the eutectoid temperature of about 723 °C, cooling method becomes decisive: slow cooling preserves a ductile, standard-compliant material, whereas rapid water quenching produces a stronger but markedly less ductile material with a suppressed yield plateau, failing the minimum elongation requirement. Both the maximum temperature reached and the post-fire cooling method must therefore be considered when assessing the residual load-bearing capacity of fire-affected S235JR steel elements.

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EXPERIMENTAL STUDIES OF DEFLECTIONS IN REINFORCED CONCRETE BEAMS SUBJECTED TO BENDING: MATHEMATICAL MODELS

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ABSTRACT

In reinforced concrete structural elements, it is necessary to limit and not allow excessive deformations from service loads. Excessive deflections and cracks with unacceptably large widths can disrupt the normal functioning of reinforced concrete structures, make building occupants feel uncomfortable, and disrupt the aesthetic appearance of buildings or facilities under service conditions, even if the stiffness and load-bearing capacity are sufficient. Limiting deflections is a mandatory step in structural design.

The article analyzes a series of tests for the determination of deflections in reinforced concrete beams constructed of concrete without prestressing of the reinforcement. Approximating equations have been proposed to determine the vertical displacements and the displacements of the supports, the deflections have been calculated and compared with those obtained experimentally.

A methodology is proposed for experimental determination of deflections at different load values for 12 reinforced concrete beams, grouped into 4 series, subjected to four-point bending test. The series differ in provided longitudinal bottom reinforcement, concrete cover and reinforcement ratio. The spans (3 m) are the same for all beams. Simultaneously, on the day of the beams' preparation, test specimens were also made from the same concrete mix. To determine the cylindrical compressive strength, tensile strength at splitting and modulus of elasticity of concrete, 24 cylindrical and 12 prismatic test specimens were prepared. To determine the strength and strain characteristics of the reinforcing steel, 3 test pieces of each diameter of the reinforcing bars used in reinforced concrete beams were tested. For experimental determination of vertical displacements at characteristic points of the beams, 5 inductive displacement transducers were used. The experiment was realized with a measuring complex for collecting, recording and processing the results, consisting of multi-channel measuring devices UPM 100 and Spider 8, a pressure sensor in the compression press, inductive displacement transducers and a computer configuration. The software products Catman Professional and Microsoft Excel were used to collect and process the results. For each beam, the cracking moment was determined theoretically and experimentally, which divides the development of deflection into 2 states. The location and outline of the first cracks in the region with constant bending moment and the cracks along the entire beams in stabilized crack formation stage are presented. The deflections at characteristic points of the reinforced concrete beams at different loading stages were investigated. The experimental dependences of displacements as a function of load are presented. Approximating equations were proposed and their accuracy was assessed using the parameter R^2. The accuracy of the proposed functions was verified for each beam with the calculated relative errors.

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EXPERIMENTAL STUDY ON CHLORIDE ION PENETRATION IN CONCRETE WITH VARYING CONTENTS OF CO-FIRING BOTTOM ASH

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ABSTRACT

The utilization of industrial by-products such as bottom ash from the co-firing process of coal and biomass (BACB) has emerged as a sustainable approach to enhance concrete performance while reducing environmental impact. BACB possesses pozzolanic and fine granular characteristics, making it a potential substitute for natural fine aggregates. This study investigates the effect of varying BACB contents on the compressive strength and chloride ion penetration resistance of concrete. Experiments were conducted using 0%, 25%, 50%, 75%, and 100% BACB as sand replacement by volume. All specimens were water-cured and tested at 28 days for compressive strength and rapid chloride permeability test (RCPT) to assess durability performance. The results showed that compressive strength increased with higher BACB content, where 100% replacement achieved the optimum value of 23.17 MPa, higher than the control mix of 21.12 MPa. The RCPT current–time data demonstrated a consistent decrease in current with increasing BACB content. The control mix exhibited the highest current (153.79 mA at the beginning and stabilizing at 6.96 mA after 360 minutes), while the 75% mix showed the lowest and most stable current (70.62 mA to 6.27 mA), corresponding to a very low permeability category (751.35 Coulombs). The chloride penetration depth also decreased in most mixtures, recorded at 21 mm (control), 20 mm (25%), 18 mm (50%), 19 mm (75%), and 27 mm (100%). Incorporation of BACB as fine aggregate improves strength and chloride resistance, making it suitable for making high durable concrete.

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EXPLORING ACADEMIC LIBRARIES AS COGNITIVE ENVIRONMENTS: WAYFINDING, WAYLOSING

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ABSTRACT

Contemporary academic libraries function as complex environments supporting studying, research, social interaction and prolonged presence on campus. Their quality depends not only on formal composition but also on spatial diversity, comfort and the ability to support different modes of use. Research in neuroscience and environmental cognition suggests that the physical structure of architecture plays an important role in how people perceive, interpret and mentally map their surroundings. Architectural space can function as a framework organizing sensory stimuli into a coherent whole and guiding movement through the built environment (Arbib, 2021). In this sense, architecture is not only a set of functional zones but a spatial system that structures experience, perception and emotion. Designing library environments therefore requires attention not only to specific activities but also to spatial qualities that influence orientation, exploration and engagement. Architectural space may simultaneously support efficient wayfinding and opportunities for exploratory movement or “waylosing,” understood as a voluntary departure from predefined paths in order to discover places within the building. This duality reflects the human tendency to explore environments while maintaining a sense of orientation and security.

The paper investigates spatial conditions that encourage users to stay, study and explore in academic library buildings. Particular attention is given to elements of functional-spatial layout such as atria, visual connections within the interior, relationships between interior and exterior and smaller secluded areas allowing individual concentration. These elements support multiple patterns of use, from collective presence to individual retreat. The analysis suggests that clear spatial organization combined with visual connectivity, diversity of spatial scales and opportunities for both orientation and discovery can encourage prolonged presence and varied forms of academic activity. In this way, contemporary academic libraries function not only as repositories of knowledge but also as architectural environments shaping the experience of learning within the broader landscape of the university campus.

The research is based on in-situ observations conducted between 2022 and 2026 using structured survey forms, analysis of floor plans and spatial configurations and a review of relevant literature. Preliminary findings are illustrated through selected case studies:

- the Jacob-und-Wilhelm-Grimm-Zentrum in Berlin (designed by: Max Dudler, 2009),
- the Toronto Metropolitan University Student Learning Centre (designed by: Snøhetta, Zeidler Architects, 2015),
- the Town House building at Kingston University in London (designed by: Grafton Architects, 2019).

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FACTORS SHAPING THE DEVELOPMENT AND SPATIAL CONFIGURATION OF A MINING CITY: A HISTORICAL-SPATIAL ANALYSIS OF HEGANG, CHINA

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ABSTRACT

Mining cities are shaped not only by the location and exploitation of mineral resources, but also by the industrial, infrastructural, institutional, and social systems established around extraction. Existing studies have examined the spatial effects of mining activities, industrial location, transport infrastructure, urban life-cycle stages, and broader economic and policy drivers. However, many focus on specific periods, recent land-use change, or relatively broad categories of influence. Less attention has been paid to how concrete factors interact across successive stages of coal-industrial development to shape the long-term development and spatial configuration of a single mining city.

This study examines Hegang, a major coal-mining city in Northeast China, from the discovery and early exploitation of coal in 1914 to the present. It asks which factors shaped the city's formation, development, and spatial configuration during different stages of coal-industrial development, and how these factors operated and interacted over time. The research draws on local chronicles, mining-bureau records, historical maps, planning documents, statistical materials, and information concerning mines, railways, processing facilities, workers' settlements, and public-service institutions. Drawing selectively on mining-city life-cycle research, while adapting the periodization to Hegang's specific historical and institutional context, the study employs historical periodization and historical-spatial analysis to reconstruct the development of its coal-industrial and urban systems and to compare the dominant factors operating across different stages.

The preliminary analysis indicates that Hegang did not develop through the continuous outward expansion of a single urban centre. Instead, the dispersed distribution of coal resources and mines, together with railway construction and the establishment of production, residential, and public-service facilities around individual mining units, produced a multi-clustered urban configuration. The relative importance and combination of factors changed over time. Resource location and transport infrastructure were especially important during the early formation of mining settlements; different resource-development regimes shaped industrial expansion and spatial organisation; and state investment, mining-enterprise organisation, labour migration, and enterprise-provided social services further consolidated the close relationship between production and urban life.

By placing coal extraction, transport, settlement, social services, and institutional change within a continuous historical-spatial framework, the study provides a more detailed explanation of how multiple factors jointly shaped the development and spatial configuration of a mining city.

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FALSE COLOUR MAP FOR LUMINANCE DISTRIBUTION VISUALIZATION IN UNREAL ENGINE

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ABSTRACT

Virtual reality and game engines are increasingly employed as tools for architectural lighting design and analysis, enabling immersive and quantitative evaluation of light distribution in virtual environments. Unreal Engine 4 (UE4) has demonstrated the capability to reproduce accurate light distributions when light sources are properly calibrated. False colour maps of luminance values are among the most widely used outputs in lighting design, as they allow rapid visual assessment of light distribution quality. However, the integration of such visualisation tools directly within a game engine's rendering pipeline remains limited in the literature. This paper aims to develop and present a false colour luminance visualisation system fully integrated within the UE4 rendering pipeline, capable of providing real-time spatial luminance visualisation directly within calibrated virtual environments. The system captures the rendered scene in high dynamic range, extracts luminance values for each pixel, and maps them to a colour scale. The visualisation operates directly within the game engine, before any image processing is applied, ensuring that the colours displayed reflect the actual light levels in the scene. The system also responded automatically to changes in lighting configuration, updating the colour scale without any manual input. To validate the approach, the same environment was modelled in DIALux evo and luminance values at reference points computed in both software were compared. Preliminary results suggest that the generated false colour visualisations accurately reflected the luminance distribution of the scene. The proposed system provides an integrated, real-time false colour luminance visualisation tool for virtual environments in UE4, to enhance the representation of lighting simulation results, facilitating a more comprehensive analysis of luminance across the rendered scene. The approach offers a practical framework for lighting designers and researchers, and establishes a foundation for future extensions including wider scene coverage and integration with immersive VR workflows.

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FLOOD RISK IN CRITICAL POINTS OF THE CITY OF JULIACA: GEOSPATIAL ANALYSIS AND CITIZEN PERCEPTION OF SUSTAINABLE DRAINAGE

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ABSTRACT

Flood risk management in urban areas is crucial for mitigating the impacts of extreme weather events, yet the integration of geospatial analysis and citizen perception remains underexplored. In the city of Juliaca, Peru, this study aimed to assess flood hazards through spatial analysis and gauge public perception of sustainable drainage systems. Utilizing a combination of geospatial data, including terrain slope, NDWI from Sentinel2 imagery, geological maps, and projected precipitation under the SSP1-2.6 scenario, we delineated flood-prone areas across Juliaca's urban polygon. The simulation indicated that 26% of the total area is at high risk. Surveys of 156 local traders revealed significant perceptions of direct damage caused by flash floods, particularly affecting property and income, whilst indirect impacts, such as rehabilitation costs, showed less statistical significance. The survey on attitudes towards sustainable drainage systems demonstrated a marked increase in acceptance following informational interventions, indicating a positive shift in perception towards environmental management strategies. Furthermore, information sessions have proven effective in increasing acceptance of sustainable solutions such as stormwater drainage, which represents a key opportunity to mitigate future impacts and strengthen urban resilience. These findings underscore the complex interplay between spatial flood risk and public perception, highlighting the need for targeted policies that address immediate damage and bolster economic resilience. The study contributes to a deeper understanding of flood risk in urban environments, emphasising the importance of integrating geospatial analysis with community engagement to improve resilience.

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FRACTURE PERFORMANCE OF SUSTAINABLE SELF-COMPACTING CONCRETE INCORPORATING RED MUD AND STEEL FIBER

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ABSTRACT

This study investigates the influence of incorporating industrial waste material and steel fibers on the fracture toughness of self-compacting concrete (SCC). A total of 18 notched SCC beam specimens (100 × 100 × 500 mm) were prepared and tested under three-point bending. Red mud (RM), a by-product of the Bayer aluminum production process, was utilized as a partial replacement of ordinary Portland cement at 20%. Five types of steel fibers with different shapes and aspect ratios were examined, including hooked-end fibers (60 and 30 mm), straight fibers (21 and 13 mm), and flat-end fibers (50 mm). Six concrete mixtures were developed, each containing 1% fiber volume fraction. In addition to fracture behavior, the study evaluates the fresh and mechanical properties of SCC. The results indicate that the addition of steel fibers reduces the workability of fresh SCC mixtures. However, fiber incorporation significantly enhances mechanical performance and fracture resistance. Notable improvements were observed in peak load capacity, deflection at failure, and crack mouth opening displacement (CMOD), indicating improved ductility and energy absorption capacity of the fiber-reinforced SCC.

Corresponding Author: Hassan M. Magbool

FRAMEWORK FOR STRUCTURING DIGITAL PLACEMAKING CONTENT BY FORM AND TOPIC

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ABSTRACT

It is widely accepted that digitalization, as a global megatrend and cross-cutting issue, has a significant impact on all aspects of urban development, including on Placemaking. Placemaking is commonly defined as the practice of shaping public spaces, giving them meaning, and fostering emotional connections with the citizens who frequent them. In the digital era, experimentation, co-creation, and design have expanded into digital spheres, including digital facades, screens, and digital installations (three-dimensional objects). Digital Placemaking, also known as hybrid placemaking, urban media or media architecture, brings together practitioners and researchers from various disciplines - such as architecture, urban planning, design, and art - to examine how the progressive development of physical spaces can be achieved through local digital technologies that deepen the connection between people and places and enable broad public participation (Hoggenmüller & Hespanhol 2017). One of the most popular examples is the 3D-cat on a screen in Shinjuku, a neighborhood of Tokyo, which blends advertisements with public digital artwork and has become a major tourist attraction. A main difficulty in the field presently is the distributed discourse and terminology when working on and with digital placemaking, which limits the development of shared knowledge across disciplines. To bridge the diverse scientific and artistic sources that do not yet exchange due to different incentives for creation and funding streams, the paper introduces a framework to structure both topics and forms of digital placemaking content.

To obtain a framework of these fields, we evaluated a selection of 15 case studies from the last 10 years, including one interactive prototype developed and tested by the research team at OWL University. In addition to topics and form of content, the comparative analysis also includes type of visualization tool (e.g., dashboards), type of public space, source, form of content, developed by public/private entity, and objective of the interface. The variations in the categories derive from open coding and are complemented by findings from literature research.

It was found that advertising and arts are widely established topics in digital elements in public spaces. Furthermore, the findings indicate that the visualization of data and publicly relevant information is growing in importance, driven by academia testing new technologies and public institutions (municipalities, public utility providers, etc.) using them to demonstrate transparency and being “digital”. However, it is debatable whether it serves as a token or offers real benefits to public discourse and better-informed citizens. To address the newly identified trend, the paper also examines how public data and information are communicated through digital interfaces and how they relate to closely discussed topics such as nudging and situated visualization. This framework can be applied to adequately plan strategies for publicly-initiated digital placemaking, opening them up to artistic content, and, in general, to enable a fruitful exchange between different disciplines that digitally build public spaces.

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FROM ABSENCE TO STRUCTURE: TRANSPOSITION AS A TOOL FOR REINTERPRETING ARCHITECTURAL MEMORY

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ABSTRACT

This paper addresses the problem of architectural intervention in places where physical traces of the past have disappeared, and collective memory has become fragmented. In such contexts, conventional approaches based on reconstruction or preservation are often inadequate. The study therefore examines alternative spatial strategies that do not rely on the reproduction of original forms. The research is based on a case study of the village of Alekšince (Slovakia), focusing on two sites with disrupted historical continuity: the vanished manor house in the center of the village and the former Jewish cemetery located on its periphery. Both sites are understood as carriers of weakened or partially erased memory, where the absence of physical structures limits their legibility in the present spatial context. The methodological approach combines analytical interpretation with a design-based experiment. Instead of reconstructing lost architectural forms, the proposal tests the transfer of spatial relationships as a method of working with memory. The key operation consists of the transposition of the spatial grid of the former Jewish cemetery into the site of the demolished manor house, thereby reinterpreting an existing historical structure in a different spatial context. The study demonstrates that architectural memory can be mediated through spatial transformation rather than direct representation. It shows that memory is not necessarily bound to its original location but can be rearticulated through the transfer of spatial structures. The paper contributes to architectural heritage discourse by defining transposition as a method for working with lost or inaccessible historical layers, where absence becomes an active component of the design process.

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FROM COMPUTER-AIDED DESIGN TO BUILDING INFORMATION MODELLING: REFRAMING BIM EDUCATION AT THE FACULTY OF ARCHITECTURE, CZECH TECHNICAL UNIVERSITY IN PRAGUE

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ABSTRACT

Introduction: Building Information Modelling (BIM) marks a fundamental paradigm shift in contemporary architectural production, moving the industry away from isolated digital drafting toward data-rich, collaborative lifecycle information management. While advanced architectural practices routinely use BIM environments to support complex spatial design and multidisciplinary coordination, academic integration remains slower and uneven. Many architectural schools in Central Europe continue to treat BIM as an isolated technical elective or software tutorial rather than as a core architectural design methodology.

Objectives: This study aims to evaluate how BIM pedagogy can be systematically reframed at the Faculty of Architecture, Czech Technical University in Prague. It investigates the transformation from traditional computer-aided design training toward an integrated educational model that connects conceptual studio design, technical coordination, information management, and professional readiness.

Methods: The research applies a qualitative case-study methodology based on the development and initial implementation of the redesigned course “Design Computing I – BIM” at FA CTU. The pedagogical framework is informed by constructivist learning theory, experiential learning, and reflective practitioner models. Curricular mapping evaluates the course across four operational dimensions: vertical continuity between study levels, horizontal integration with architectural design studios, interdisciplinary collaboration, and alignment with openBIM workflows and ISO 19650 information management principles.

Results: The preliminary findings indicate that software-centric instruction alone does not prepare students for the collaborative demands of contemporary architectural practice. An effective BIM education model requires a modular design computing framework in which Common Data Environment protocols, Industry Foundation Classes data exchange, coordination processes, and information management are embedded into project-based design tasks. In this model, BIM shifts from a secondary documentation tool to a primary environment for data-informed architectural design.

Conclusion: The paper concludes that modernizing architectural education requires an institutional shift in which digital technology is treated as an intrinsic design methodology rather than a technical afterthought. The FA CTU pilot framework offers a transferable curriculum model for Central European architecture schools facing similar challenges of digital and pedagogical transformation.

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FROM PROMPT TO RENDER: AI-DRIVEN 3D MODELLING AND VISUALIZATION IN INTERIOR ARCHITECTURE

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ABSTRACT

The integration of artificial intelligence (AI)-based tools into architectural practice is redefining design processes and 3D visualization. This paper investigates the potential of using AI in the generation of interior architectural forms and in optimizing the architect/designer workflow.

The research is based on an applied study conducted in the SketchUp environment, correlated with AI tools for 3D modeling conditioned by text prompts or 2D images, as well as AI-assisted rendering solutions. The methodology consists of comparing traditional modeling and visualization stages with an AI-augmented workflow, analyzing execution time, number of iterations, level of formal complexity, and the degree of control over the final result.

The results highlight that the use of AI significantly accelerates the process of generating and testing formal variations, facilitating the rapid exploration of alternatives and the creation of furniture objects with complex geometries. At the same time, the study identifies limitations related to the precise control of details, constructive coherence, and dependence on the quality of the prompt used.

The conclusions indicate that AI tools do not replace professional expertise but function as a catalyst for the creative and decision-making process. Beyond the sphere of visualization, they actively contribute to formal development and to the optimization of early design stages, outlining a relevant direction for interdisciplinary research in architecture and digitally assisted design.

Corresponding Author: Sebastian Fejes-Sava

FROM STATIC MODELS TO LIVING DIGITAL TWINS: A MULTI-SENSOR FRAMEWORK FOR DYNAMIC MONITORING OF SHORELINE ENGINEERING INFRASTRUCTURETYPE

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ABSTRACT

Recent advances in geospatial technologies have significantly improved the generation of high-resolution Digital Twins for engineering infrastructure. Nevertheless, most existing implementations remain static products created from periodic surveying campaigns, limiting their usefulness for operational monitoring and infrastructure management in highly dynamic coastal and inland water environments.

This presentation introduces the concept of a Living Digital Twin, continuously updated through the integration of heterogeneous sensor observations within a unified geospatial framework. The proposed architecture combines high-resolution UAV photogrammetry, airborne and mobile laser scanning, multibeam echosounder surveys, precise GNSS positioning, hydrological monitoring, and environmental sensor streams to maintain an evolving digital representation of shoreline engineering infrastructure. Rather than focusing solely on geometric reconstruction, the framework integrates spatial, temporal, and semantic information, enabling continuous updating of terrain, water boundaries, engineering structures, and environmental conditions.

The proposed workflow is illustrated using Digital Twin implementations developed for inland water environments, where multi-epoch hydrographic surveys and real-time hydrological observations are integrated within a GIS-based data model. The presentation demonstrates how dynamic data streams increase temporal fidelity, improve change detection, and provide a consistent representation of infrastructure operating under continuously changing environmental conditions.

Finally, the presentation discusses future directions toward fully operational Digital Twins integrating IoT sensor networks, Structural Health Monitoring (SHM), artificial intelligence, and predictive maintenance. The proposed concept illustrates the transition from static three-dimensional models to continuously evolving geospatial Digital Twins capable of supporting resilient infrastructure management and evidence-based decision-making throughout the asset lifecycle.

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FROM THE KONYA TEKEL BUILDING TO DEPO NO. 4: ADAPTIVE REUSE OF AN EARLY REPUBLICAN INDUSTRIAL HERITAGE BUILDING

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ABSTRACT

Constructed in 1935 during the Early Republican Period as the Inhisarlar (later TEKEL) Regional Directorate Building and used for many years to store and sell state-monopolized products, this building constitutes an important example reflecting Konya's industrial heritage. Over time, as its operational functions declined, the building fell into disuse and was on the verge of being forgotten in the city's collective memory; however, with the growth of conservation awareness, it was subsequently reevaluated. This study aims to critically examine both the historical significance of an industrial building from the Early Republican era and its functional transformation following restoration. During the restoration process, the building's original materials and structural features were preserved, modern additions were kept to a minimum, and reinforcement as well as necessary improvements were carried out. As part of the adaptive reuse process, the building was transformed into Depo No. 4, a multifunctional venue hosting cultural, artistic, and social activities. In this way, flexible spaces for exhibitions, workshops, and conferences were designed, establishing a new focal point for both residents and visitors. The extent to which this new function aligns with the building's historical identity and whether it offers a sustainable model of use form the central questions of this paper. The findings indicate that the adaptive reuse process has established a generally balanced relationship between heritage conservation and contemporary use, while reinforcing the building's contribution to urban memory and public life. Hence, the case of Depo No. 4 provides insights into the conservation and adaptive reuse of industrial heritage within the context of Early Republican architecture. The study contributes to current debates on sustainable adaptive reuse by examining the relationship between conservation, urban memory, and contemporary use, while emphasising the importance of long-term evaluation in assessing the effectiveness of adaptive reuse interventions.

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GENESIS AND CONTEMPORARY TRENDS IN OLYMPIC INFRASTRUCTURE DEVELOPMENT

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ABSTRACT

Introduction: The Olympic Games have long functioned as a catalyst for urban change and as a reflection of prevailing urban planning paradigms. This paper focuses on analysing the genesis of the Olympic Games' development and identifying contemporary trends in the planning and construction of Olympic infrastructure through selected examples.

The Milano–Cortina 2026 Winter Olympic Games represent an attempt to redefine the concept of "Olympic life". The organisers have maximised the use of existing high-quality sports facilities that are naturally embedded within the landscapes of cities, valleys and Alpine settlements in Northern Italy. The spatial structure of the Games extends from the metropolitan environment of Milan through the Dolomite valleys around Cortina to the high-altitude border region of Livigno.

The historical evolution of the Olympic Games is characterised by a gradual transition from the temporary solutions of early Olympic Villages to today's complex projects of urban transformation. At the same time, Olympic infrastructure has shifted towards multifunctional, environmentally and socially sustainable urban structures. Increasing emphasis is placed on the creation of long-term legacy and on urban regeneration that goes beyond the immediate framework of sporting competitions.

Particular attention is paid to the systematic integration of Olympic investments into the strategic development plans of metropolitan areas and regions. Contemporary Olympic Games demonstrate that the development of Olympic infrastructure can fundamentally reshape the urban profile of cities and influence their long-term planning visions. The Olympic event is thus increasingly applied as a tool for supporting a polycentric territorial model at the regional scale, with the latest trend being extraterritorial and mixed solutions (multiple cities, multiple regions) involving several cities and regions.

Objectives: The aim of this paper is to analyse the genesis of Olympic infrastructure development and to identify the main contemporary trends in its planning and implementation. Special attention is given to the shift towards multifunctional, environmentally and socially sustainable structures, as well as to the growing importance of the so-called Olympic legacy.

Methods: Methodologically, the paper is based on a comparative analysis of selected Olympic Games, with particular emphasis on the Milano–Cortina 2026 Winter Olympic Games. The analysis draws on a review of academic literature, planning documents and urban concepts that reflect the spatial organisation of the Games, the extent of reuse of existing infrastructure, and their integration into broader territorial development strategies.

Results: The results indicate a significant paradigmatic shift in the organisation of the Olympic Games towards polycentric and multi-location models. The Milano–Cortina 2026 case demonstrates a new approach to "Olympic life", based on the use of existing sports facilities dispersed across cities, valleys and Alpine regions of Northern Italy. This model supports regional balance and strengthens the long-term functional and spatial value of the territory.

Conclusion: Modern Olympic Games are increasingly becoming an instrument of strategic territorial development at the regional scale. The emphasis on legacy, urban regeneration and sustainability leads to the application of extraterritorial and mixed solutions involving multiple cities and regions. Olympic infrastructure thus ceases to be a one-off investment tied solely to a sporting event and becomes an integral part of long-term urban and planning visions.

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GEOPHYSICAL PROSPECTING STUDIES WITH A VIEW TO A NEW THERMAL GROUNDWATER ABSTRACTION FOR THE MEDICAL SPA OF ÁGUAS - PENAMACOR (PORTUGAL)

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ABSTRACT

The Águas Medical Spa was recently authorized by the Portuguese state, following an extensive series of geo-environmental studies (characterization of the physical-chemical and microbiological quality of the sulphureous water from the Traditional Spring – NT; inventory and characterization of all groundwater sources in the region – springs, wells, boreholes, and mines; geological and hydrogeological conditions, amongst other factors), which led to several mechanical prospecting boreholes and, consequently, to the groundwater abstraction with definitive characteristics (Well AM4). The groundwater at NT, as well as having a very low flow rate, was contaminated. The groundwater from Well AM4 retained the chemical profile of the groundwater at NT, but without, contamination, and therefore, following analytical monitoring comprising monthly physic-chemical and microbiological analyses, amongst other studies, over a hydrological year (12 consecutive months), it was certified as natural mineral water (NMW), with a flow rate of around 0.8 L/s, for use in medical spa treatments at a small health facility. However, at this stage, it is necessary to increase the available water flow to facilitate a thermal spa project with dimensions and features that comply with current health and well-being standards. Accordingly, in this article, following a brief overview of the main previous geo-environmental studies, the aim is to present the results and associated discussions of geophysical prospecting studies, specifically electrical resistivity tomography (ERT), as well as the most suitable locations for the construction of this new groundwater abstraction. In the studies, the data were combined using two measurement devices, the 'Schlumberger–Wenner' and the 'Dipole–Dipole'. Six profiles were carried out, each 710 m long, to achieve a survey depth of around 150 m. The main findings of this work were the identification of five major fractures, as well as zones with conductive anomalies, which are, in principle, associated with sulphureous groundwater. The main results of this work were the identification of five main fractures, as well as zones with conductive anomalies, which are, in principle, associated with sulphureous groundwater. Thus, it is anticipated that the new groundwater abstraction will be reached, which, if it proves productive and chemically identical to that already licensed by NMW, will undergo a legalization process to be integrated into the Águas Medical Spa's exploitation plan, and consequently lead to the construction of a new bathroom, which will help, amongst other things, boost health tourism in the region.

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GEOTECHNICAL AND TERRESTRIAL 3D LASER SCANNING ANALYSIS FOR THE STABILITY ASSESSMENT OF THE KOŚCIUSZKO MOUND IN KRAKÓW

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ABSTRACT

The Kościuszko Mound in Kraków is one of the most important historical earth structures in Poland and represents a unique example of a large anthropogenic earth structure of exceptional cultural and historical value. Due to its age, construction method, and long-term exposure to environmental factors, the mound requires systematic monitoring and geotechnical assessment to ensure its long-term stability and safety. The aim of this study is to assess the geotechnical safety of the Kościuszko Mound based on geotechnical investigations, geodetic monitoring, and terrestrial laser scanning (TLS) measurements.

The analysis includes the identification of geological and engineering conditions using available geotechnical documentation and high-resolution TLS data. The geotechnical characterization made it possible to determine the variability of soil parameters such as shear strength, degree of compaction, and moisture susceptibility, which enabled the identification of potential weakness zones within the mound structure.

Terrestrial 3D laser scanning provided precise spatial data describing the geometry of the mound surface, allowing for the detection of subtle surface changes, erosion processes, and local slope deformations.

The stability assessment indicates that the Kościuszko Mound is particularly sensitive to fluctuations in groundwater levels, intense rainfall events, and locally inefficient drainage, which may contribute to the formation of slip surfaces in areas composed of heterogeneous and less compacted soils. Based on the analysis, a set of reinforcement measures has been proposed, including modernization of the drainage system, localized slope stabilization, and the implementation of long-term monitoring based on TLS and geotechnical measurements.

The findings demonstrate the effectiveness of an integrated approach to the protection and risk management of historic earthen structures.

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GEOTECHINCAL PARAMETERS IN THE PRELIMINARY GEOENVIRONMENTAL ASSESSMENT OF THE TORTOSENDO CEMETERY, PORTUGAL

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ABSTRACT

Cemeteries should be understood not only as collective-use infrastructures and symbolic spaces, but also as active geoenvironmental systems in which burial-related sources, subsurface migration pathways, and potentially exposed receptors interact over time. Within this framework, soil geotechnical properties play a critical role, as they influence infiltration, vertical percolation, contaminant attenuation, and subsurface water circulation. This study analyses the main geotechnical parameters of soils at the Tortosendo Cemetery, in the municipality of Covilhã, central Portugal, and its immediate surroundings, in order to evaluate their contribution to the preliminary interpretation of subsurface geoenvironmental behaviour.

The methodological approach combined geomorphological and geological characterisation of the study area with in situ geotechnical investigation, piezometer installation, and laboratory soil testing. Ten piezometers were installed using two complementary methods: Dynamic Probing Super Heavy (DPSH) and shallow boreholes drilled using a mechanical auger. The DPSH tests provided information on the vertical variability of soil resistance, whereas the auger boreholes enabled the collection of representative disturbed samples for particle-size distribution analysis and determination of Atterberg limits. Additional soil samples were collected from open graves at a depth of approximately 2 m. The interpretation was further supported by derived parameters, including empirical estimates of permeability.

The results indicate that the cemetery is situated on a low-gradient hillslope within a small headwater zone divided between two local sub-basins, a geomorphological setting that may influence both surface runoff patterns and subsurface flow organisation. DPSH profiles revealed low resistance values in the shallowest layers, consistent with loose granitic residual soils, followed by a gradual increase in resistance with depth, suggesting denser or less weathered materials. Laboratory analyses confirmed the predominance of granular soils, mainly sandy to gravelly-sandy materials, with low fines content and low plasticity. These characteristics are consistent with hydrogeotechnical conditions that may favour infiltration and vertical percolation in specific sectors.

Overall, the findings demonstrate that soil geotechnical parameters are fundamental to the preliminary geoenvironmental assessment of cemetery sites. The proposed approach provides a robust technical basis for subsequent hydrogeological investigation, vulnerability assessment, and preliminary cemetery management support.

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GREEN ROOFS AS A TOOL FOR URBAN CLIMATE ADAPTATION: HYDROLOGICAL PERFORMANCE, EVAPOTRANSPIRATION POTENTIAL AND METHODOLOGICAL CHALLENGES IN THE CENTRAL EUROPEAN CONTEXT

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ABSTRACT

Green roofs are often presented as a simple adaptation measure for two urban problems at once: rapid stormwater runoff and the overheating of dense built-up areas. In reality, their performance is not a fixed property of the roof assembly, but the result of a changing water balance. Substrate depth, antecedent moisture, rainfall intensity, vegetation condition, evaporative demand and season all determine how much water is retained, how quickly runoff begins and how much cooling can be produced through evapotranspiration. This is especially important in Central Europe, where a roof may retain a large part of annual rainfall through many small and medium events, but may provide much weaker protection during intense storms or in periods when the substrate is already saturated. The direct transfer of retention values from wetter or milder climates into regional design practice can therefore lead to misleading expectations. This paper evaluates green roofs as a coupled hydrological and microclimatic measure using a case study of an administrative building in Prague with a flat roof area of 514.38 m². Three vegetated assemblies, extensive, semi-intensive and intensive, are compared with an impervious reference roof. Annual runoff is calculated from runoff coefficients used in Czech design practice, while maximum retained volume is derived from the manufacturer-declared water capacity of the individual roof layers. The short-term hydraulic response is assessed by a fifteen-minute design-storm calculation according to ČSN EN 12056-3 and ČSN 75 9010. Evapotranspiration potential for the 2019–2023 period is estimated by the Penman–Monteith method for a reference grass surface using meteorological data for Prague. The results show that replacing the impervious roof with a vegetated assembly can substantially reduce calculated annual runoff and peak discharge. The impervious reference roof discharged about 270 m³ per year, while the calculated annual runoff decreased to 180 m³ for the extensive roof, 90 m³ for the semi-intensive roof and 30 m³ for the intensive roof. Maximum retained volume increased from 18.0–33.4 m³ for extensive systems to 51.7–78.0 m³ for semi-intensive systems and 162.9–195.2 m³ for intensive systems. The design-storm calculation produced peak flows of 8.93, 5.58 and 3.35 $l \cdot s^{-1}$ for the extensive, semi-intensive and intensive roof, respectively. The Penman–Monteith estimate indicated that approximately 72% of annual rainfall could potentially be returned to the atmosphere, but this value must be read as an upper estimate rather than as the measured behavior of a specific roof under summer water stress. The study shows that the deepest assembly is not automatically the most balanced regional solution. For Central European buildings, robust design should combine suitable substrate depth, high water-holding capacity, drought-resilient vegetation and, where appropriate, moisture-controlled irrigation supplied from stored rainwater.

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GRID SHELLS SHAPED ON THE BASIS OF NATURAL FORMS

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ABSTRACT

Curvilinear steel bar structures are increasingly applied in the design of various roof coverings. The primary aim of this study was to develop highly efficient steel grid shells inspired by the principles of nature-based solutions and biomimicry. The methodological framework integrated form-finding via 3D scanning, parametric grid generation, and structural optimization. Spatial geometries were created by capturing high-resolution mesh data from natural marine shells using a high-precision optical 3D scanner. These organic surfaces were subsequently parameterized into analytical NURBS surfaces. By applying diverse grid topologies—namely quadrilateral and triangular—along with widely and closely spaced boundary supports , a comprehensive set of structural forms was generated parametrically. Steel was adopted as the structural material. The generated spatial models were subjected to structural analyses under realistic environmental actions, specifically wind and snow loads, calculated for Rzeszów, Poland. To achieve maximum material efficiency, an iterative size-optimization process was conducted under strict ultimate and serviceability limit state constraints, minimizing total structural mass while preventing buckling and excessive deflection. Structural analysis demonstrated that the biomimetic spatial curvature significantly enhanced internal force distribution, enabling high load-transfer efficiency. The structural response of the generated grid shells was heavily dominated by axial load transfer, keeping bending moments and shear forces to minimal levels—an attribute highly favorable from an engineering standpoint. A comparative evaluation was conducted using the amount of construction material per unit of covered surface area as the primary criterion. Contrary to initial assumptions, the study conclusively established that triangular grid topologies are the most efficient in terms of overall structural mass. Due to the high number of interconnecting elements per unit area, internal forces were efficiently shared, allowing for slender cross- sections. Specifically, the densely supported triangular configuration achieved the lowest total structural mass of 1008 kg. Conversely, quadrilateral grids required much larger individual profile dimensions, yielding a considerably higher total structural mass of up to 1391 kg. Furthermore, dense boundary supports anchored at every perimeter node facilitated a highly uniform transfer of internal forces, drastically mitigating localized stress concentrations compared to sparse configurations. The study confirmed that the adopted morphogenetic framework enables the generation of efficient, lightweight, and economical structural systems that unite aesthetic innovation with sustainable material usage in engineering practice.

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HERITAGE-DRIVEN URBAN REGENERATION AND SPATIAL VITALITY: A GIS-BASED ANALYSIS OF HUMAN MOBILITY AND COMMERCIAL ACTIVITY IN COLUMBIA CIRCLE, SHANGHAI

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ABSTRACT

László Hudec, an influential architect active in the Shanghai concessions during the 1920s–1940s, contributed to the overall planning of Columbia Circle and designed several representative buildings within the area, including the Sun Ke Apartment and his own residence. The site has since been incorporated into Shanghai's historical building protection system and redeveloped into Shangsheng Xinsuo, a representative adaptive reuse project of architectural heritage.

Against this background, this study takes Shangsheng Xinsuo as a case study and operationalizes the concept of spatial vitality into three primary dimensions: activity intensity, functional diversity, and temporal persistence, capturing the dynamic characteristics of human activities and functional elements across space and time. Within a GIS-based analytical framework, multi-source geospatial datasets, including human mobility data and commercial POI data, are integrated. A combination of kernel density estimation, spatial overlay analysis, and clustering techniques is employed to construct a multidimensional indicator system. These indicators are spatially aligned and coupled with the geographic distribution of heritage buildings to identify association patterns and spatial heterogeneity between heritage elements and urban vitality.

Furthermore, a spatiotemporal comparative analysis is conducted by incorporating temporal datasets to examine changes across different time periods, enabling the construction of a multi-dimensional evidence chain linking spatial patterns, temporal dynamics, and institutional contexts. This approach facilitates a more comprehensive understanding of the socio-spatial transformation process.

The results reveal a significant spatial coupling between the adaptive reuse of heritage buildings and increased pedestrian concentration, as well as enhanced diversity of commercial activities, indicating that heritage spaces can promote higher levels of spatial utilization and functional mix. However, further analysis suggests that such vitality is not driven by heritage elements alone, but rather emerges from the combined effects of spatial design interventions, capital investment, and institutional support. This multi-factor coupling mechanism indicates that architectural heritage functions as a key embedded component within a complex urban system, whose influence is amplified or mediated through interactions with external conditions.

These findings challenge deterministic interpretations of "heritage-driven" urban regeneration and suggest that architectural heritage should be understood as one of the important contributing factors rather than a sole driving force in socio-spatial transformation processes. By integrating GIS-based spatial analysis with urban regeneration theory, this study establishes an empirically grounded analytical framework centered on spatial coupling and spatiotemporal evidence chains, providing both theoretical insights and practical implications for achieving a balance between functional transformation and vitality enhancement in historically protected urban areas.

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HISTORICAL BUILDING SURVEY OF MIKLÓŠI FACTORY IN PLEŠIVEC, SLOVAKIA

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ABSTRACT

This article describes historical building survey focused on the Miklóši factory located in the cadastral area of the town of Plešivec in the historical region of Gemer in southeastern Slovakia.

The Miklóši factory complex is situated approximately 2 km from the center of Plešivec, outside the town's built-up area. It consists of an administrative and residential building, which was the subject of the research, and several production and operational facilities.

Due to its location, the site stands apart from the town, situated in the landscape of the „Štítnický potok" valley, on the site of an old ironworks which, according to some sources, was already in operation during the period when the area was administered by the prominent Bubek family (14th-16th centuries). In addition to this ironworks, there were at least 10 other ironworks in the „Štítnický potok" valley in the past; apart from the Miklóši family's ironworks, only small remnants of a single other ironworks in the village of Slavošovce have survived to this day. In contrast, almost the entire complex has been preserved in Plešivec. The ironworks in the Štítnický Potok valley processed raw materials from the region's rich ore deposits. The valley was at the heart of the Gemer iron ore and ironworking region, which, particularly from the Middle Ages to the early 20th century, was one of the key areas of iron production in Upper Hungary; Gemer is often referred to as the "Iron heart of Central Europe."

The subject of the research was a building that served both administrative and residential purposes. It was inhabited by the family of the owner of the hammer mill (later a factory). Within the factory grounds, the building in question stands out among the other structures due to its architectural and material design. Most of the administrative and residential building was constructed in the 18th century, and although the building underwent several renovations in later periods, the structures from the time of its construction and from the extensive renovations at the turn of the 19th and 20th centuries - when the entire complex underwent significant reconstruction and modernization-have largely been preserved. Together with the annexes and surrounding buildings necessary for the residential and industrial functions of this complex, it forms an unusual and well-conceived architectural ensemble.

Given that the building in question, along with its associated halls, a chimney, and several other buildings, stands on its original site since at least 18th Century, the value of this complex is high and important for preserving the industrially "urbanized" character of the site as well as for preserving the legacy of the rich history of the metalworking industry in the region, renowned for its iron ore processing since the Middle Ages.

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HOW MUCH WILL THE TAILINGS SETTLE? CPTU-BASED PREDICTIONS MEET NUMERICAL MODELLING AT ŻELAZNY MOST TSF

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ABSTRACT

The continuous growth of the copper industry results in increasing volumes of post-flotation tailings requiring safe long-term storage. This study investigates the settlement behaviour of tailings deposited in the Żelazny Most Tailings Storage Facility (Poland), one of the largest tailings storage facilities in the world. Settlements under variable deposition conditions were estimated using indirect and direct CPTU-based methods and verified with Modified Cam Clay (MCC) numerical modelling. Depending on the applied method, predicted settlements ranged from several dozen centimetres to over 3 m. Despite quantitative differences, all approaches indicated a consistent trend in tailings behaviour, while the direct CPTU method showed high agreement with MCC modelling results.

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IDENTIFYING AREAS AT RISK FROM HEAVY RAINFALL IN URBAN AREAS – A PROPRIETARY METHOD FOR WORKING WITH OPEN-SOURCE DATA

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ABSTRACT

This article introduces a proprietary methodology for identifying urban problem areas related to rainwater retention using open-source spatial data and advanced GIS tools, with Katowice selected as the pilot city. The research presents an integrated approach combining geospatial analysis, remote sensing indicators, and open data sources to generate synthetic maps highlighting zones most vulnerable to heavy rainfall and low water retention. The significance of the data collection methodology presented in the workflow diagram, lies in its reliance on high-quality, open-source spatial and environmental data to ensure transparency, cost-effectiveness, and adaptability of the analysis process across various urban contexts. The results confirm the tool's effectiveness, as they closely match historical flood events and observed consequences, supporting its utility in urban planning and climate adaptation strategies. The authors recommend further development through full automation of data harmonization, integration of machine learning for improved result accuracy, and creation of standardized, scalable modules for use in other cities and regions. Expanded capabilities should include compatibility with urban planning systems and dynamic data updates to maximize impact in mitigating urban flood risks and enhancing city resilience. The open-data-driven method not only democratizes access to analytical tools for municipalities and researchers but also enhances replicability and scalability for other cities. By facilitating continuous updates and extensions using new or improved datasets from public sources, it supports faster, data-driven urban planning and policy-making in response to evolving climate and rainfall patterns. The methodology distinctly underscores that the breadth and reliability of open-source data are foundational for identifying, comparing, and prioritizing intervention zones, thus laying the groundwork for effective urban resilience measures in the face of climate change.

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IMPACT OF INTERNAL INSULATION ON THE BEHAVIOUR OF BRICK WALLS: A NUMERICAL SIMULATION STUDY

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ABSTRACT

The article addresses the problem of thermal insulation in historic buildings. It is well known that the application of conventional external thermal insulation systems is usually not permissible in such structures due to the need to preserve the original architectural character of historic façades. In such cases, one of the few available options for improving the energy performance of building envelopes is the application of internal insulation. However, this solution may significantly alter the hygrothermal conditions within the wall and increase the risk of moisture accumulation in historic masonry.

The aim of this study was to evaluate the hygrothermal performance of masonry walls in a historic building after the application of different internal insulation systems. The analysis was carried out for the external walls of the northern wing of the Convent of the Sisters of St Catherine in Orneta. The assessment was performed using numerical simulations of coupled heat and moisture transport carried out with the WUFI software, combined with laboratory-determined hygrothermal properties of historic brick masonry obtained from tests on samples extracted directly from the building.

Three internal insulation systems with different moisture transport characteristics were analysed, including a vapour-tight system based on PIR boards, a partially capillary-active system (iQ-Therm), and a capillary-active system based on calcium silicate boards. The simulations were performed for two levels of initial wall moisture, representing typical service conditions as well as a scenario with locally increased moisture content. The evaluation was primarily based on the analysis of relative humidity evolution at the interface between the insulation layer and the masonry over a long-term period.

The results indicate clear differences in the hygrothermal behaviour of the analysed insulation systems. Capillary-active insulation systems provide more favourable drying conditions for historic masonry compared with vapour-tight solutions, thereby reducing the risk of long-term moisture accumulation within the wall. These findings highlight the importance of considering moisture transport properties of insulation materials during the design process and demonstrate that the appropriate selection of internal insulation systems is crucial for the safe energy retrofit of historic buildings.

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IMPACT OF RECYCLED GLASS AND CARBON GEOGRID FIBERS ON THE RUTTING RESISTANCE OF ASPHALT CONCRETE

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ABSTRACT

The contamination of reclaimed asphalt pavement (RAP) with synthetic materials a significant challenge for modern pavement engineering. According to the EN 13108-8 standard, the permissible content of foreign matter (Group 2) in RAP is strictly limited to 0.1% (m/m). Given the lack of comprehensive research on the influence of geogrid fibers originating from the milling of asphalt pavements on the performance of new asphalt mixes containing such synthetics, it is essential to determine their actual impact. This study primarily aims to evaluate the rutting resistance of asphalt concrete (AC) incorporating recycled glass and carbon geogrid fibers, previously used for pavement reinforcement. The research sought to verify whether exceeding the allowable synthetic contamination threshold negatively affects the properties of AC 16W and AC 22W mixes used in the binder course. Fiber parameters were optimized to ensure high-performance asphalt concrete characteristics. The analysis considered two qualitative factors: mix type and fiber material (glass, carbon), and two quantitative factors: fiber length (1 cm to 5 cm) and fiber content (0.2% to 1.0% by mass). The experimental program focused on mechanical properties regarding permanent deformation resistance, conducted via the Wheel Tracking Test (WTT) in accordance with EN 12697-22 (small device, 10,000 cycles at 60°C). Key performance indicators included the Wheel Tracking Slope (WTS_{AIR}) and Proportional Rut Depth (PRD_{AIR}). The results demonstrated that both the asphalt mix type and the percentage of geogrid fibers significantly influence WTS_{AIR} and PRD_{AIR} parameters. All tested variants met the normative requirements for the wheel tracking slope ($WTS_{AIR} \leq 0.15$ mm/1000 cycles), with results stabilizing between 0.05 and 0.09. The proportional rut depth (PRD_{AIR}) proved to be a more sensitive indicator, revealing a non-linear relationship: optimal properties were achieved at a fiber dosage of 0.2–0.6%. Exceeding the 1.0% threshold with a fiber length of 5 cm resulted in PRD_{AIR} values surpassing the permissible limit of 7.0; this was interpreted as a saturation effect, leading to fiber entanglement and loss of compaction homogeneity. Glass fibers exhibited higher operational stability, reinforcing the mix structure, whereas carbon fibers—due to their high elastic modulus—generated local stress concentrations at higher dosages. The findings indicate that, when properly optimized, geogrid fibers can function as micro-reinforcement, enhancing the rutting resistance of asphalt concrete. These results are of fundamental importance for engineering practice, proving that the presence of recycled glass and carbon geogrid fibers in RAP at levels exceeding 0.1% (m/m) does not necessarily degrade the quality of the asphalt mix, provided that fiber quantity and length are controlled. This work provides a scientific basis for the broader implementation of circular economy principles in road construction, promoting the efficient use of contaminated RAP while maintaining full pavement durability and contributing to CO2 reduction and sustainable development goals.

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IMPACT OF SELECTED INSTALLATION PARAMETERS ON THE RESISTANCE OF PLASTIC ANCHORS IN FOAMED CONCRETE SUBSTRATE

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ABSTRACT

The aim of the research was to determine the resistance under tension load of plastic anchors in foamed concrete substrates of three different densities corresponding to their use in individual building elements.

The research was conducted similarly to the needs of fastener manufacturers and contractors. The limited amount of previous work in this field poses a challenge in properly determining the pull-out strength of building fasteners in foamed concrete.

Previous research has shown variations in the pull-through strength of fasteners installed in foamed concrete with different types of anchor material. In this study the results of the pull-out strength tests of fasteners installed in foamed concrete were presented.

The substrate was made of foamed concrete of different densities in laboratory conditions. The fastener installation parameters were varied, among other factors, due to the drill diameter used to drill the hole. Traditional plastic anchors made of polypropylene, commonly used in the construction market, from a manufacturer with a current European Technical Assessment were selected for testing. There were two effective anchorage depth – 50 mm and 70 mm. In the test were used sleeve of ø10 mm.

This article presents the results of the pull-out tests on the plastic anchors installed in foamed concrete substrate. The correlations between the resistance under tension load of plastic anchors installed in foamed concrete substrate and compressive strength of hardened foamed concrete were determined. The resistance under tension load of plastic anchors increased with compressive strength of foamed concrete, independent on different drill diameter used to drill the hole. Furthermore, the effect of embedment depth has a significant impact on the resistance under tension load of plastic anchors installed in foamed concrete.

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IMPROVING WATERFRONT PEDESTRIAN DISTRICTS IN DUBAI: A USER-PERCEPTION STUDY

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ABSTRACT

Waterfront pedestrian districts have become an important part of Dubai's recent shift toward open-air, mixed-use urban environments that support outdoor activity, social interaction, leisure, and urban vibrancy in a hot-arid context. Within this context, Al Seef was selected as a case study because it represents a prominent waterfront pedestrian district along Dubai Creek, combining contemporary retail, dining, and leisure functions with traditional Emirati-inspired public-realm design. Previous research has examined Al Seef within Dubai's emerging pedestrian-oriented urban developments, identifying it as a distinctive case shaped by its waterfront setting, souq-like morphology, narrow pedestrian passages, enclosed public spaces, and traditional design character. This paper extends that work by examining how users perceive walkability, public-realm quality, and everyday activities in Al Seef. The study adopts a qualitative case-study approach based on 20 semi-structured interviews, field observation, and photographic documentation. Participants were identified only by user category: Emirati citizen, UAE resident, or visitor/tourist. The interviews examined users' reasons for visiting Al Seef and their suggested improvements. Field observation was organized around four selected public-realm areas derived from traditional Emirati spatial vocabulary: Sikka, Al Saha, Al Baraha, and Al Maydan. These areas were used to document walking routes, shaded passages, waterfront edges, gathering spaces, seating, commercial frontages, traditional design elements, and visible public-realm activities. The findings show that users are attracted to Al Seef because of its waterfront setting, walkable environment, traditional Emirati-inspired design character, dining options, social atmosphere, views, and opportunities for photography. Participants describe the place as visually distinctive and enjoyable for walking, socializing, and spending time. The observational images support these findings by showing how pedestrian passages, open gathering areas, waterfront edges, shaded routes, and commercial frontages support walking, stopping, dining, photography, and informal social interaction. At the same time, participants identify improvement needs related to Arabic signage, seating areas, greenery, cafés, and environmental comfort. The paper argues that the success of waterfront pedestrian districts should not be evaluated only through spatial configuration or commercial attractiveness, but also through users' lived experience of walkability, comfort, activity, visual identity, and public-realm quality. The study contributes to sustainable urban planning by offering user-based insights for improving waterfront pedestrian districts in Dubai and comparable hot-arid cities.

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INCLUSIVE RESTAURANT ACOUSTICS FOR VISUALLY IMPAIRED USERS: EXPLORING PARAMETRIC POTENTIAL

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ABSTRACT

In the current context of performance-based design, parametric design offers the opportunity to integrate acoustic criteria from the early stages of architectural conception. This paper investigates the role of sound-absorbing panels and walls with parametric structures in optimizing the acoustic environment of restaurants, with a particular focus on improving the experience of people with visual impairments. In Romania, approximately 90,000 people live with visual impairments, and their participation in social life and everyday activities such as dining out is often affected by the uncontrolled acoustic performance of interior spaces—an aspect that is rarely addressed systematically in traditional design practices.

In dining and social spaces characterized by high levels of ambient noise and increased reverberation time, auditory clarity becomes essential for spatial orientation, social interaction, and the reduction of cognitive overload. For users with visual impairments, auditory perception represents a fundamental tool for navigating and interpreting space, which transforms acoustic control into a critical component of inclusive design.

In addition to using ambient sounds and voices for orientation, many individuals rely on active and passive echolocation mechanisms. By analyzing subtle differences between direct and reflected sound, users can estimate the distance to obstacles, the size of the interior volume, or the openness of a spatial area. A space with chaotic echoes or excessive diffuse noise can compromise orientation ability and the perception of spatial boundaries.

The paper proposes a parametric approach to the design of sound-absorbing panels and walls, in which geometry, perforation density, relief depth, and the distribution of absorbing elements are generated and optimized algorithmically within digital environments integrated with acoustic simulation. Within this framework, parameters such as reverberation time, absorption coefficient, and sound field distribution become active design variables rather than mere post-design evaluation indicators. Thus, acoustic systems are conceived as adaptive structures capable of responding to spatial volume, materiality, and occupancy levels through variable three-dimensional configurations and perforated or textured surfaces with parametrically generated patterns that combine acoustic performance with formal expressiveness.

The research methodology includes comparative acoustic simulations, parametric modeling, and user experience evaluations to demonstrate that the early integration of acoustic design significantly reduces reverberation, improves speech intelligibility, and supports auditory orientation.

The results highlight the potential of parametric design to transform sound-absorbing panels and acoustic walls from technical elements added later in the process into generative components of the architectural concept. The study argues for the development of a practice of “parametric acoustics,” in which performance, inclusion, and formal expression are interconnected through advanced digital tools.

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INFLUENCE OF CRACKING IN A MASONRY BUILDING ON ITS DYNAMIC CHARACTERISTICS

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ABSTRACT

Cracking of masonry elements is one of the most common forms of structural damage encountered in engineering practice. The resulting cracks, caused for example by uneven foundation settlement, thermal effects, and operational loads, lead to local degradation of structural stiffness and, consequently, may affect the global dynamic response of the entire structure.

The aim of this study is to assess the influence of cracking in selected masonry elements on the basic dynamic parameters of a building. For this purpose, a numerical model of a single-storey masonry building was developed in Autodesk Robot Structural Analysis. Two calculation variants were adopted: a reference model representing an uncracked structure, and a cracked model in which the presence of damage was taken into account by modifying the mechanical properties of the elements, primarily through a reduction in stiffness. This approach made it possible to quantitatively evaluate the effect of local stiffness degradation on the dynamic behaviour of the building.

For both variants, a dynamic analysis was performed to determine the natural frequencies and the corresponding mode shapes. A comparison of the results obtained for the uncracked and cracked models showed that even a slight reduction in the stiffness of masonry elements leads to noticeable changes in the dynamic characteristics of the building. The obtained results confirm the importance of considering cracking in numerical analyses of masonry structures and indicate that local damage may be significant for the global assessment of the technical condition of a structure.

The obtained results provide a basis for further research on more complex structural models, considering different degrees of cracking as well as the influence of crack location and propagation on the dynamic response of masonry buildings.

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INFLUENCE OF INITIAL IMPERFECTIONS ON THE POST-BUCKLING BEHAVIOUR OF SWAY STEEL FRAMES

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ABSTRACT

The study investigates the influence of structural imperfections, particularly their sign and direction, on the strength and overall response of sway steel frame. Such structures are commonly encountered in steel construction and are characterized by their sensitivity to geometric nonlinearities. Depending on the orientation of the initial imperfections, these systems may exhibit either stable or unstable post-buckling behavior, which in turn leads to substantial variations in their load-carrying capacity. This duality makes their accurate assessment particularly challenging and highlights the importance of adopting advanced analytical approaches. In the present research, structures of this category are examined as representative examples where the differences between linear and nonlinear analyses become especially pronounced. Linear methods, although widely used due to their simplicity, often fail to capture the true structural response when large displacements and second-order effects are involved. For this reason, the use of nonlinear analysis is strongly recommended. The load-carrying capacity derived from such analyses—considering an initial imperfection amplitude equal to that prescribed by Eurocode 3 but with varying directions—is systematically compared with the corresponding design resistance obtained through standard code-based procedures. This comparison leads to particularly insightful and, in some cases, unexpected conclusions. Initially, the analytical solution of the elastic nonlinear behavior of a simplified single-degree-of-freedom system is presented, both in the absence and in the presence of initial imperfections. This approach allows for a clearer understanding of the fundamental qualitative characteristics governing the response of these structures. Subsequently, a detailed comparison is carried out between results obtained from elastic analyses that incorporate geometric nonlinearity, analytical solutions available in the literature for similar frame configurations, and strength values calculated according to established design codes. The results of the analyses performed on sway steel frames demonstrate not only the strong dependence of load-carrying capacity on the direction of initial imperfections, but also the considerable conservatism inherent in the resistance values predicted by Eurocode 3. More broadly, the findings of this study emphasize the limitations associated with linear buckling analysis when used to estimate elastic failure loads in frame members. For structural systems such as those examined here—where both imperfection direction and axial shortening of columns play a decisive role—nonlinear analysis emerges as an essential and indispensable tool for achieving reliable and realistic design outcomes.

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INFLUENCE OF SUPERABSORBENT POLYMERS ON COMPOSITE PROPERTIES

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ABSTRACT

The paper deals with the possibility of utilizing superabsorbent polymers (SAP) in cement and blast-furnace slag composites. Research is focused on the influence of highly absorbent materials on fresh mixtures properties and on selected mechanical and physical properties of hardened specimens. Attention is to the ability of SAP to absorb and subsequently release the water retained in the gel structure, acting as an internal water reservoir within the composite material.

Experimental mixtures with various forms and dosages of SAP were prepared and tested. The specimens were subjected to a set of standard and non-standard tests aimed to evaluate their mechanical and physical behaviour, including the influence of SAP on water retention and overall material performance.

Obtained results indicate the potential applicability of SAP in construction materials, especially in relation to internal curing processes and modification of selected material properties. The findings may contribute to the further development of advanced composites for construction engineering practice.

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INFLUENCE OF WASTE TYRE RUBBER TYPE ON THE PHYSICAL AND MECHANICAL PROPERTIES OF CONCRETE

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ABSTRACT

The rapid growth of the automotive sector has led to a sharp increase in waste tyres and other rubber products, raising growing environmental concerns around the world. The large amounts of rubber waste produced by end-of-life tyres, retreading processes, and worn-out artificial turf fields can have a negative impact on air, soil, and water quality, emphasising the importance of finding more sustainable reuse solutions. Since concrete is one of the most widely used construction materials, using waste rubber as an aggregate offers a practical way to reduce waste and preserve natural resources. This study investigates the impact of two types of waste tyre rubber — fine devulcanised rubber and shredded fibre-shaped rubber particles — on the density, ultrasonic pulse velocity (UPV), flexural strength, and compressive strength of fine-grained concrete after 7 and 28 days of curing, as well as its microstructure (SEM) and leaching behaviour of heavy metals (Co, Cr, Cu, Ni, Pb, and Zn). In the experimental programme, 15% of the fine aggregate was replaced with the two types of tyre rubber. The results show that fine-grained concrete containing devulcanised tyre rubber with significantly finer particles exhibited greater reductions in density (16%), UPV (about 13%), flexural strength (about 12%), and compressive strength (about 30%) than concrete containing fibre-shaped rubber particles. The leaching results showed that only Cu leached from the control concrete and from concrete samples containing waste tyre rubber. Compared with the control, leaching of Cu from concrete containing fibre-shaped rubber particles did not change significantly, whereas leaching of Cu from concrete containing devulcanised rubber particles increased by 5.8 times. SEM analysis revealed that fibre-shaped rubber particles bonded better with the cement matrix, resulting in a microstructure closer to that of the control samples. Conversely, devulcanised rubber particles had a smoother hydrophobic surface, leading to weaker interfacial transition zone between aggregate and cement matrix and the formation of weak zones in the concrete. This contributed to the reductions in density and mechanical performance observed.

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INNOVATIVE ANCHORAGE SYSTEMS FOR THIN-WALLED FAÇADE ELEMENTS MADE OF CARBON CONCRETE COMPOSITE

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ABSTRACT

Thin-walled façade elements are increasingly gaining importance in the construction industry as a sustainable, resource-efficient alternative to conventional reinforced concrete. Modern façade systems are characterized by large surface areas combined with minimal material usage, often enabled by advanced materials such as carbon-reinforced concrete or ultra-high-performance concrete (UHPC). These innovative, slender elements offer both economic advantages and significant reductions in resource consumption for building envelopes. Despite these benefits, thin-walled façade elements pose considerable technical challenges. Their reduced thickness requires new approaches for manufacturing, transportation, installation, and anchorage. While conventional concrete façades typically require thicknesses of 90–100 mm, carbon concrete panels can satisfy structural and serviceability requirements at thicknesses as low as 30 mm, resulting in a reduction in volume and weight by a factor of three to four.

Traditional anchoring systems, such as dowels or anchor channels, are not suitable for these slender elements, as their load-bearing capacity strongly depends on sufficient component thickness. Consequently, the development of new connection technologies is essential for modular and lightweight construction using thin-walled façade concrete elements. To address this challenge, innovative anchorage systems based on shape memory alloys (SMA), also referred to as memory steel, have been developed. These systems enable stable, form-fitting, and linear connections for large-format façade elements. At Frankfurt University of Applied Sciences (FRA-UAS), in close collaboration with industry partners, novel connectors combining SMA and slender steel components have been designed and tested.

A key advantage of these connectors is the activation of memory steel during installation, which eliminates the need for mechanical access and significantly simplifies on-site assembly while improving safety. Comprehensive laboratory investigations were conducted to optimize application parameters and verify long-term load-bearing behaviour. Test specimens were subjected to a constant tensile load of 4 kN using helical compression springs. In addition, field tests demonstrated the effectiveness of the deformation process, allowing façade panels to be installed without direct access to the joint.

The compact design of the system enables the replacement of individual panels without dismantling adjacent elements, enhancing maintainability. Furthermore, durability tests confirmed that the selected high-manganese, iron-based SMA exhibits strong resistance to corrosion.

Overall, this research provides a promising foundation for the development of advanced connection systems in lightweight construction. By significantly reducing material consumption and concrete volume, the proposed solution contributes to improved resource efficiency and reduced energy demand in the construction sector.

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INSIGHTS FROM EXPLORING INTERDISCIPLINARY EDUCATION AND INTEGRATING STUDENT LEARNING INTO REAL-WORLD RESEARCH ON EXISTING BUILDINGS

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ABSTRACT

The present article explores students' perceptions, attitudes, and learning strategies in relation to interdisciplinary forms of education supported by digital technologies, with particular emphasis on their application within the construction industry. The study focuses on how the integration of advanced digital tools, such as Building Information Modeling (BIM), is transforming traditional educational approaches that have long relied on conventional CAD-based design methods. By moving beyond isolated, discipline-specific workflows, these technologies enable a more holistic and collaborative approach to learning that reflects real-world professional practice. The research examines key factors influencing students' readiness and willingness to adopt digital solutions, including prior technical knowledge, perceived usefulness, ease of use, and the level of institutional and pedagogical support. In addition, the article assesses the broader implications of digital technology integration for both educational environments and future professional practice, particularly in terms of interdisciplinary collaboration, problem-solving, and decision-making processes. Ultimately, the aim of the study is to evaluate whether the systematic use of digital tools in education can enhance students' motivation, interest, and active engagement in the field, while also better preparing them for the evolving demands of the construction industry.

Corresponding author: Denis Konovalov

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IN SITU ASSESSMENT OF VIBRATIONS GENERATED BY A K9 SELF-PROPELLED HOWITZER IN A BUILDING WITH A VIBRATION-ISOLATED INDUSTRIAL FLOOR

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ABSTRACT

The rapid growth of railway infrastructure, particularly high-speed rail, has increased the importance of issues related to the vibrations transmission to the surrounding environment and their impact on the vibration comfort of people in buildings located near railway lines. One of the most effective measures for reducing railway vibrations is the installation of vibration-isolating mats within the track structure. Their effectiveness depends largely on material properties, which determine the behavior of the mats under dynamic loads generated by train operations. The aim of this study is to present the results of material tests on modern vibration-isolating mats, along with an evaluation of selected physical and dynamic parameters regarding their effectiveness in reducing vibrations under high-speed railway operating conditions.

The comprehensive laboratory tests conducted as part of this study included the determination of key material parameters, such as the static and dynamic stiffness moduli, as well as fatigue tests in accordance with current UIC standards and guidelines. The test results were analyzed with a particular focus on identifying the relationship between stiffness parameters and vibration damping efficiency within the frequency range perceptible to humans. The tests demonstrated that the material properties of vibration-isolation mats have a direct impact on the level of vibration reduction, and their optimization allows for a significant increase in the effectiveness of vibration isolation by improving the vibration comfort of people in buildings.

The results obtained form the basis for constructing numerical models of the track–subgrade–building structure system, enabling the analysis of vibration propagation and the assessment of the impact of different mat types on the level of vibrations transmitted to the surrounding environment. Combining material testing with numerical analyses allows for the identification of the most effective vibration isolation solutions and the development of guidelines for the rational selection of mats depending on soil conditions, structural characteristycs, and operational conditions.

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INTEGRATED ASSESSMENT OF CEMENT COMPOSITE PROPERTIES USING ULTRASONIC PULSE VELOCITY AND SHRINKAGE

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ABSTRACT

The measurement of ultrasonic pulse propagation provides a comprehensive insight into the properties of the tested material. Two main measurement approaches are used: manual measurements, in which the transducers must be manually applied to the tested element, and automatic methods, which involve placing fresh material in a mold and monitoring changes in ultrasonic pulse velocity passing through the element. This study focuses on the second approach, particularly on the IP-8 Ultratest system, which is used to perform our own experimental investigations. Such measurements, carried out from the first minutes after preparing the mixture, enable a broad analysis of material behavior, as they allow the identification of relationships and simultaneous evaluation based on ultrasonic pulse velocity variation curves and their values, including:

-Determination of Young's modulus
-Estimation of strength / real-time evaluation of strength development
-Monitoring of the hydration process
-Determination of setting time
-Assessment of sample quality
-Shrinkage analysis

Our research focuses primarily on understanding the behavior of fiber-reinforced cement composites, particularly composites containing waste fibers obtained from wind turbine blades, produced through the mechanical shredding of wind turbine blade components. The use of material from wind turbine blades in construction is a significant issue, given the global problem of the quantity of decommissioned turbine blades and the difficulties associated with their decomposition and recycling due to the complexity of their construction – balsa wood, microfibre-reinforced thermoset composites (glass, basalt, carbon) and, very often, resin matrices. We have considered the aspect of recycling this material in depth in [1].

Our study includes a comparison of manual and automatic measurement methods, such as ultrasonic pulse velocity measurements using the Proceq concrete tester and the IP-8 system, as well as the determination of setting time using the Vicat method and analysis of the ultrasonic velocity curve obtained from the IP-8 system. The conducted analyses indicate that the application of fibers does not significantly affect the hydration process, as confirmed by ultrasonic pulse velocity variation curves. The dynamic modulus of elasticity of the material is mainly determined by ultrasonic pulse velocity, while the influence of Poisson's ratio on its value is negligible. At the same time, the fiber-reinforced sample exhibits a higher dynamic modulus of elasticity compared to the reference sample. The analysis of setting time showed that the three-tangent method proposed by Garnier et al. provides results closest to those obtained using the Vicat method. [2]

Currently, the research is being extended to include shrinkage measurements, which will help evaluate the influence of fibers on hardening processes. The measurement of shrinkage in cement composites will enable the assessment of their susceptibility to cracking and long-term durability. Comparison of reference and fiber-reinforced samples will allow the evaluation of the influence of fibers on the reduction of shrinkage deformations.

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INTEGRATED GEOSPATIAL DATA ACQUISITION AS A BASIS FOR BIM-ORIENTED MODELLING OF A DAM STRUCTURE

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ABSTRACT

The creation of Building Information Modelling (BIM) datasets for existing hydraulic infrastructure depends on a spatial basis that is both geometrically accurate and complete enough to represent the whole engineering object. For dams, this requirement is difficult to meet with one survey method, because the monitored environment includes visible structural components, earthwork bodies, surrounding terrain, technical facilities and submerged reservoir parts. Terrestrial laser scanning can describe accessible concrete and structural surfaces in high detail, but it cannot capture the reservoir bottom. UAV photogrammetry provides broader surface coverage and a coherent visual record of the terrain, but it is limited above water surfaces and on steep or near-vertical faces. Hydrographic surveying supplies the missing underwater morphology, yet it does not replace the structural detail needed for BIM-oriented modelling. This paper therefore presents an integrated geospatial workflow for preparing a reliable spatial basis for subsequent Scan-to-BIM development of Pancharevo Dam on the Iskar River in Bulgaria. The workflow combines terrestrial laser scanning, UAV photogrammetry and single-beam hydrographic surveying within one geodetic reference framework. A control network established by GNSS RTK measurements in the BGS2005 coordinate system and the Black Sea height datum provided the common reference for all datasets. Terrestrial laser scanning with a Trimble TX6 scanner was used to document the dam wall, spillway, technical structures and adjacent terrain. The registered and target-georeferenced TLS dataset achieved an overall residual of 28 mm, which confirms its suitability for structural documentation and BIM-oriented geometric interpretation. UAV photogrammetry was carried out with a DJI Mini 3 Pro and processed in Agisoft Metashape Professional. From 284 acquired images, 272 were successfully aligned. The resulting photogrammetric products achieved a ground resolution of 1.21 cm/pix, an independent check point RMSE of 1.14 cm and a dense point cloud of more than 44.6 million points, together with a DEM and orthomosaic. The hydrographic survey extended the model below the water surface by producing corrected bottom elevations from single-beam depth measurements, including corrections for sound velocity, water level variation and transducer immersion. The three datasets were then integrated through their shared coordinate and height reference into one coherent spatial representation of the dam body, spillway, embankment, surrounding terrain and near-dam reservoir bottom. The results confirm that terrestrial, aerial and hydrographic data are complementary and, for this type of structure, technically necessary. The study also makes clear that the output is not a finished BIM model, but a verified geometric basis for Scan-to-BIM procedures, technical documentation, spatial analysis and future digital-twin applications.

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INTEGRATING BIM AND LEAN PRINCIPLES FOR SUSTAINABLE DECONSTRUCTION PLANNING: A CASE STUDY ON A PREFABRICATED STUDENT RESIDENCE BUILDING IN ROMANIA

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ABSTRACT

The construction sector is a major contributor to global energy consumption and carbon emissions, with building demolition generating significant waste and environmental impact. This research investigates the synergistic application of Building Information Modeling (BIM) and Lean Construction principles to optimize the end-of-life phase of prefabricated buildings, which are prevalent across Eastern Europe. Through an in-depth case study of the C7 student residence in Bucharest, Romania-a typical prefabricated building constructed in 1967-the study demonstrates a methodology for transitioning from conventional demolition to systematic, value-driven deconstruction. An experimental campaign assessed in-situ material properties and structural integrity of concrete and steel reinforcement after approximately 55 years of service. Results showed that concrete compressive strengths (26.5-29.3 MPa) exceeded original design specifications (C24/25), and steel reinforcement exhibited no significant degradation, confirming the potential for direct reuse. These findings were integrated into a detailed BIM model (LOD 350) to create a comprehensive digital material inventory and component-specific material passports documenting location, dimensions, properties, condition, and recommended end-of-life pathways. Lean principles-including value stream mapping, flow optimization, and pull planning-were applied to design an optimized deconstruction sequence prioritizing material recovery. The integrated BIM-Lean framework enables recovery of approximately 65% of building materials by weight for direct reuse or high-value recycling, compared to 30-40% in conventional demolition. Reusing 4,800 m² of concrete panels avoids approximately 720 t CO_2-eq, with additional emissions savings from steel reuse. This research demonstrates that combining in-situ testing, BIM-based digital documentation, and Lean planning significantly enhances deconstruction outcomes, offering a replicable and sustainable model for managing the vast aging prefabricated building stock across Eastern Europe and advancing circular economy principles in the construction sector.

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INTEGRATING CARBON DESIGNER 3D, LCA, AND CIRCULAR ECONOMY METRICS INTO EARLY-STAGE EMBODIED CARBON ASSESSMENT OF REGENERATIVE BUILDING DESIGN.

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ABSTRACT

The building and construction sector is responsible for 37–40% of worldwide greenhouse gas (GHGs) and CO_2 emissions, with around 10% arising directly from the embodied carbon of building materials and construction activities. In recent years, attention has been concentrated on the regulation of operational carbon, while embodied carbon across the full life cycle from raw material extraction to end-of-life remains insufficiently explored, particularly in relation to regenerative building design supported by circular economy and low-carbon principles. Currently, no unified quantitative framework links early-stage Carbon Designer 3D (CD3D) massing studies with cradle-to-cradle LCA and circular economy (CE) metrics to assess circular and low-carbon design performance. This research develops and applies an integrated framework that combines: early-stage carbon modelling using CD3D within OneClick LCA; a full life cycle assessment of Modules A1–A5, B4–B5, C1–C4, and D following EN 15978; the Building Circularity v2 assessment; and a multi-criteria environmental impact analysis (GWP, acidification, eutrophication, resource depletion). The framework is assessed on a hotel building. Regenerative design strategies, based on circular and low-carbon principles, reduced embodied GWP by 20%; Module D delivered a 10% avoided emissions benefit; and circular strategies extended material service life by 10 years.

The results indicate that integrating circular and low-carbon design principles with LCA and CE methodologies in a single computational workflow can deliver approximately 35% -40% embodied carbon reductions at early design stages and yield a net positive environmental outcome when Module D is accounted for. The study offers practical guidance for designers, engineers, and policymakers working toward near-zero embodied carbon and energy-related CO_2 emissions (CO2eq) in mining and construction industry.

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INTENSIFICATION OF URBAN FABRIC AS A FACTOR OF SUSTAINABILITY

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ABSTRACT

The contribution is focused on one of the current problems of contemporary territorial development, which is the optimization of the intensity of built-up areas. The issue of the density of urban fabric is one of the basic factors of sustainable development. By optimizing the intensity of use of the territory of the city and its parts, it is possible to achieve more compact development, increase the efficiency of its operation, as well as the vitality of the urban environment.

The current development of cities in Slovakia is characterized by two basic tendencies tied to the form of their development. These are extensive development on the periphery and the often-spontaneous intensification of inner-city structures, especially in the centers of economically strong regions.

Each of these tendencies has negative impacts on the operation and quality of the urban structure. Extensive development causes landscape erosion and increased demand for transport. On the other hand, market pressure aimed at maximizing the intensity of land use often causes a deterioration in the quality of the environment or operational problems.

The paper is aimed at assessing the current state of urban planning practice in Slovakia, with an emphasis on indicators of land use intensity. The research is aimed at assessing the density of various forms of residential structures within the spatial plans of settlements in comparison with the existing, implemented and proposed - "model-optimized" development. The paper follows the principle of differentiated density of urban structures in different locations of the city and different types of settlements.

The main objective of the research is to point out the need to optimize the forms of residential structures and their density, while affecting the specificities of a particular location and its importance, with a projection into the regulation of the territory.

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INTERPRETING ARCHITECTURAL IDENTITY IN INDUSTRIAL REDEVELOPMENT: A CASE STUDY OF BICOCCA SUPERLAB IN MILAN

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ABSTRACT

Nowadays, the most common strategies for the redevelopment of historical industrial architecture focus solely on functional upgrading or technological improvements, often disrupting the continuity of regional architectural identity. Considering this phenomenon, a critical question has arisen: how can the original architectural identity be inherited and exhibited in the new architectural outcome? To answer this question, the research in this paper develops a new methodological classification framework for architectural identity and applies it to conduct a systematic case study of the selected case, the Bicocca Superlab in Milan. This project transforms a 1950s industrial headquarters into a contemporary office complex.

The research primarily uses the qualitative case study approach. Applying the proposed classification framework, the case is analyzed through five main dimensions: semantic organization, spatial organization, relationship with context, material and construction, and function and activity. The research's key findings show that, in redevelopment, Bicocca Superlab is not preserved as a static historical relic; instead, it is systematically reconstructed through a set of effective design approaches that not only can preserve its site memory but also enhance its architectural identity. The designer exposes the architecture's existing structure while reorganizing spatial configurations to accommodate new functions, which achieves the semantic continuity of the original architecture. At the same time, it combines the use of local traditional materials and techniques with avant-garde contemporary materials and technologies to establish a balance between historical spirit and contemporary performance. The newly designed transparent curtain wall reveals the internal structure and echoes the outer historical district, thereby forming a recognizable architectural identity and harmonizing with the surrounding environment.

In conclusion, this research examines how the feature of identity of industrial architecture can be inherited, interpreted, and enhanced during redevelopment, through a systematic analysis of a typical case. By proposing a framework for architectural identity's main dimensions and applying it to the case study, the research provides a pragmatic approach to understanding how architectural identity is constituted and can be interpreted across semantic, spatial, contextual, material, and functional dimensions. At the theoretical level, the research contributes to expanding the architectural identity theory by refining its compositional classification. At the design level, the methodological framework developed in this research could serve as an assistive tool for the architectural design process; through this, the designed architecture can inherit and enhance local architectural identity while offering a new interpretation in the contemporary context.

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INTEGRATION OF DYNAMIC CO_2 LEAKAGE MODELLING INTO THE DESIGN AND EVALUATION OF MONITORING SYSTEMS FOR GEOLOGICAL STORAGE

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ABSTRACT

Geological CO_2 storage is a key component in achieving decarbonization targets; however, large-scale deployment requires the development of robust monitoring strategies capable of detecting, quantifying, and managing potential leakage while ensuring regulatory compliance and long-term operational safety. In this context, this paper presents the integration of dynamic CO_2 leakage modelling into the development and evaluation of monitoring systems for geological storage sites.

The proposed approach relies on dynamic reservoir models to simulate CO_2 migration processes in the subsurface, including both normal operational conditions and potential leakage scenarios associated with geological structures or integrity failures. A range of scenarios is analysed by varying geological and operational parameters in order to assess their impact on CO_2 distribution, reservoir pressure, and stress fields. These results are linked to observable responses obtained from geophysical and geomechanical monitoring techniques, such as 4D seismic (including DAS), gravity measurements, surface deformation, and well-based monitoring.

Based on these simulations, a sensitivity analysis of different monitoring technologies to leakage scenarios is performed, highlighting their capability to detect and quantify anomalies. This enables optimization of monitoring system design, including the selection of sensor types, acquisition configurations, and monitoring frequency, according to identified risks and site-specific conditions. Furthermore, the study explores the integration of probabilistic modelling chains and model updating techniques (data assimilation) to reduce uncertainties and improve predictive capabilities.

The developed methodology allows for the evaluation of monitoring system performance using key risk and conformance indicators, as well as the definition of operational thresholds for detecting deviations from expected behaviour, consistent with traffic-light approaches. It provides an integrated framework to support decision-making in risk management, adjustment of injection strategies, and implementation of corrective measures, thereby contributing to more efficient permitting processes and increased confidence in the safety of CO_2 storage.

The work builds upon expertise developed within the GETICA CCS demonstrator project, where dynamic models and monitoring methods for CO_2 storage were developed and assessed, and extends these results into an integrated methodological framework applicable at industrial scale and relevant for the development of future CO_2 storage hubs.

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INVESTIGATION OF THE FLOW BEHAVIOUR OF AN ASPHALT BINDER CONTAINING ENCAPSULATED PHASE CHANGE MATERIAL USING THE CROSS MODEL

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ABSTRACT

This study investigates the flow behavior of an asphalt binder modified with microencapsulated phase change material (PCM) using complex viscosity master curves and Cross model analysis. A B70/100 penetration grade bitumen was selected as the base binder, and microencapsulated PCM was incorporated at 2%, 5%, and 8% by weight of bitumen. Frequency sweep tests were performed using a dynamic shear rheometer at 40, 50, 60, and 70 °C over a frequency range of 0.01–10 Hz. Complex viscosity master curves were constructed at reference temperatures of 40 °C and 70 °C to evaluate the temperature- and frequency-dependent flow response of the neat and PCM-modified binders. The results showed that all binders exhibited a typical shear-thinning behavior, with complex viscosity decreasing as frequency increased. PCM modification generally increased the complex viscosity, particularly at 40 °C, where the effect became more pronounced with increasing PCM content. At 70 °C, the viscosity values were substantially lower and the differences among binders became less distinct due to thermal softening. Cross model analysis provided statistically significant fits for all binders, with high coefficients of determination, especially at 40 °C. The zero-shear viscosity values increased with PCM content at 40 °C, indicating improved resistance to flow under low-shear conditions. In addition, critical shear rate values suggested that PCM incorporation shifted the onset of shear-thinning behavior toward lower shear rates.

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LABORATORY METHODS FOR ASSESSING THE RISK OF BIODEGRADATION OF ETICS SYSTEMS IN TERMS OF STRUCTURE

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ABSTRACT

This article deals with the possibilities of laboratory assessment of surface porosity and roughness of ETICS (External Thermal Insulation Composite Systems), which are key factors influencing the susceptibility of facades with thin-film plasters to biological contamination. ETICS are widely used to reduce heat loss in buildings and provide indoor comfort, but their surface finish can be susceptible to the growth of microorganisms.

The study focuses on the relationship between surface structure and the occurrence of biodegradation. Surface porosity and roughness affect the ability of the surface to retain moisture, accumulate dirt, and provide a suitable environment for microorganisms to colonize. Higher porosity and coarser surface texture increase the likelihood of biological colonization, while smoother and less porous surfaces reduce the risk of contamination. Understanding these relationships is essential to predict the long-term durability of facades and to optimize the choice of plaster materials.

The article presents the main laboratory methods used to evaluate the surface properties of ETICS. They include profilometric measurement of surface roughness and porosity assessment by microscopic analysis of structures. For each method, the measurement and subsequent evaluation are described in detail.

The experimental part of the study was conducted on four samples taken from real facades with varying levels of biological contamination. The measured porosity and roughness parameters were then used to evaluate the risk of biodegradation and to compare the resistance of the individual samples. The results confirm that materials with higher porosity and roughness have a higher potential for microbial growth, while samples with smoother, less porous surfaces pose a lower risk of contamination.

In conclusion, the article shows that laboratory evaluation of ETICS surface characteristics provides an important tool for predicting biodegradation risk and supports decision making in the design of facade systems. Identifying the key parameters that influence the durability of surfaces allows for increasing the lifetime of facades, reducing maintenance requirements, and ensuring the aesthetic and functional quality of buildings over a long period of time.

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LAYERS OF TRANSFORMATION: URBAN MORPHOLOGY AND CULTURAL ATTRIBUTES IN SOCIALIST PLANNING OF ORADEA, ROMANIA (1945-1989)

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ABSTRACT

Urban development is strongly linked to political, economic, and socio-cultural aspects in various periods of time. The process of urbanisation in the communist era is seen as a broader phenomenon, not just as an urban or architectural program that considered the political ideology of the time period, economic, cultural and social ambitions frame the general context of the communist parties. These ambitions are reflected in the urban space and architecture greatly. Urban expansion was sparked as a confluence of rapid urbanisation, collective house expansion and “new man” ideology. The socialist period left a profound and lasting imprint on the urban morphology of Romanian cities. However, the spatial logic of this transformation remains underexplored at the city-specific scale. This paper examines the urban development of Oradea, Romania, during the communist era (1945-1989). Research design is constructed around three research questions and is refined as a multi-approach method. Following two sequences in an iterative manner: historico-geographical and morphological-analytical, the research considers various indicators: temporal, spatial, functional, cultural and socio-economic context of Oradea in the Socialist era. Tracing the morphological changes in the timespan, the paper examines the urban planning of the socialist regime by overlaying historical maps and producing thematic maps. Linking historic, economic, ideological and socio-cultural attributes of the 1945-1989 period, a timeline is delineated, revealing the cultural and spatial dimensions of the urban changes. The findings reveal three interconnected morphological sequences: the dissolution of the pre-existing plot structure, the introduction of new urban barriers through monumental arterial roads and boulevards and the typological stratification of the socialist housing stock from the Soviet-influenced blocks. The paper argues that reading these layers together offers a broader, integrated depiction of the spatial and cultural legacy of Socialist Romania.

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LEARNING BY REVERSE ANALYSIS: RECONSTRUCTING ARCHITECTURAL PROGRAMS FROM SPATIAL EXPERIENCE

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ABSTRACT

This paper proposes a didactic and research-oriented methodology based on reverse analysis as a tool for understanding architectural programs through direct spatial experience. Departing from conventional design pedagogy—which typically moves from concept to form—the method inverts the process, guiding students to reconstruct programmatic logic starting from the observation of existing built environments. The approach is structured around an in-situ observation framework, supported by a guided analytical sheet designed to capture key aspects of spatial experience: user behavior, patterns of movement, spatial hierarchies, dominant relationships, vertical and horizontal connections, perceptual cues, and the role of materiality and light in supporting functional intent. Through this process, students are encouraged to identify the programmatic nucleus, decode spatial relationships, and critically assess discrepancies between intended and actual use. The results indicate that reverse analysis fosters a shift from descriptive to relational thinking, enabling students to perceive architectural programs not as static distributions of functions, but as dynamic systems shaped by use, perception, and interaction. The integration of real-time observation with structured questioning enhances critical awareness and strengthens the ability to link spatial configuration to programmatic intent. Beyond its pedagogical value, the methodology is positioned as a research tool. The paper outlines its potential application within a broader doctoral study focused on early education environments (kindergartens), where reverse analysis will be employed to investigate how spatial organization supports—or contradicts—specific educational functions and behavioral patterns. By bridging teaching and research, the proposed method offers a transferable framework for analyzing architecture through use, contributing to both architectural education and evidencebased design inquiry.

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LIMITATIONS OF DIGITALIZATION IN BUILDING OPERATION AND SUSTAINABILITY

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ABSTRACT

Facility management as a discipline integrates a wide range of activities to create an optimal working environment which also contributes to reducing operating costs and increasing the competitiveness of the organization. Currently, the application of Facility Management is extremely topical, both in terms of reducing operating costs and also due to increasing the flexibility and efficiency of operational processes in a dynamic economic environment. The article points to Facility Management as a tool for better use of available resources, thereby optimizing costs. In this way, Facility Management contributes to the overall competitive position of the company and its long-term sustainability in the market. The aim of this publication is to provide an insight into the basic facts regarding Facility Management, especially its activities and possibilities and especially the barriers to digitalization to which it is exposed in Slovakia. The article focuses on clarifying the nature and objectives of Facility Management as well as its integration into the structure of organizations in order to streamline their operations. It also includes answers to questions regarding the importance and use of Facility Management for building management and an assessment of the possibilities of its digitalization for the effective management of support activities and optimization of corporate resources. At the same time, this material is intended to contribute to increasing awareness of the importance and possibilities of developing Facility Management as a strategic tool for reducing costs, increasing employee performance and overall competitiveness of organizations in the current dynamic business environment. The article highlights the role of Facility Management as a tool for accelerating and reducing the cost of processes which results in an increase in labour productivity and profitability. Facility Management is becoming the basis of professional management and administration of corporate resources and, in conjunction with the use of digital tools, is essential today for maintaining a competitive advantage in the market.

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LONG-TERM DURABILITY OF HYDROPHOBIC IMPREGNATION IN CLINKER BRICK FACADES

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ABSTRACT

Clinker brick facades are widely used in contemporary construction due to their durability, aesthetic qualities, and resistance to environmental factors. Despite these advantages, masonry facades are frequently affected by salt efflorescence and biological contamination, which reduce their aesthetic appearance and may contribute to the gradual degradation of building materials. Moisture plays a crucial role in the transport of soluble salts within porous masonry structures; therefore, limiting water penetration is an important aspect of facade protection.

Hydrophobic impregnation is widely used as a preventive treatment intended to reduce water absorption and limit the migration of dissolved salts to the surface of masonry elements. However, the long-term durability of such protective treatments under real environmental conditions remains an important issue in the maintenance and conservation of brick facades.

The aim of this study is to evaluate the long-term durability of hydrophobic impregnation applied to clinker brick facades. Particular attention is given to the assessment of surface wettability using contact angle measurements, which are commonly applied to determine the hydrophobic properties of building materials. The study focuses on evaluating the effectiveness of hydrophobic treatment in reducing moisture penetration into clinker brick surfaces.

The research includes an analysis of the mechanisms responsible for the formation of salt efflorescence, as well as the identification of environmental and material-related factors influencing moisture transport in masonry structures. Experimental investigations were carried out to assess the hydrophobic performance of impregnated clinker brick surfaces using the contact angle method.

The results indicate that hydrophobic impregnation significantly reduces the wettability of clinker brick surfaces, thereby decreasing water absorption and limiting conditions favorable for salt migration within the masonry structure. Maintaining the hydrophobic properties of facade materials plays an important role in preventing efflorescence formation and improving the durability of clinker brick facades exposed to environmental conditions. The findings of this study contribute to a better understanding of the long-term durability of hydrophobic treatments and may support the development of more effective maintenance strategies for masonry facades.

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LOW-CARBON CONCRETE INCORPORATING CO-COMBUSTION COAL–AGRO-WASTE: CORRELATING FLEXURAL STRENGTH AND GLOBAL WARMING POTENTIAL ASSESSMENT

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ABSTRACT

The increasing adoption of coal–agro-waste co-combustion in thermal power plants has generated significant quantities of co-combustion coal fly ash (CCAFA) and co-combustion coal bottom ash (CCABA), creating new challenges for sustainable ash management. Simultaneously, the concrete industry faces growing pressure to reduce greenhouse gas emissions associated with Portland cement production. This study investigates the feasibility of utilizing CCAFA as a partial replacement for Portland Composite Cement (PCC) and CCABA as a partial replacement for natural fine aggregate to develop low-carbon concrete with enhanced mechanical and environmental performance. Six concrete mixtures were prepared, comprising one control mixture and five modified mixtures incorporating 15–30 wt.% CCAFA and/or 50 wt.% CCABA. Beam specimens (100 × 100 × 400 mm) were water-cured for 28 days and evaluated through flexural strength testing in accordance with ASTM C78. Environmental performance was assessed using Global Warming Potential (GWP), while the overall sustainability of each mixture was quantified using the Flexural Strength-to-GWP Efficiency Index (I_{FS}). The results revealed that CCAFA used alone reduced flexural strength but substantially decreased GWP because of lower cement consumption, whereas CCABA alone significantly impaired flexural performance owing to its porous structure and high-water absorption. However, the combined incorporation of CCAFA and CCABA produced a pronounced synergistic effect. The optimum mixture, containing 30 wt.% CCAFA and 50 wt.% CCABA (MIX 5), achieved the highest flexural strength of 4.75 MPa, corresponding to a Strength Activity Index of 149.84%, while reducing GWP to 254.92 kg CO_2-eq/m³ and attaining the highest I_{FS} value of 0.0186 MPa·m³/kg CO_2-eq. Furthermore, MIX 5 satisfied the Indonesian flexural strength requirement for heavy-traffic rigid pavements, demonstrating that hybrid utilization of co-combustion ash can simultaneously enhance structural performance, reduce carbon emissions, and promote sustainable resource utilization in concrete production.

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MATHEMATICAL MODELING AND EXPERIMENTAL STUDY OF THE DESIGN OF A FOUR-SPACE VERTICAL PARKING SYSTEM

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ABSTRACT

In the modern world, particularly in old and densely populated cities, automobile parking represents one of the most critical challenges in urban development and transport capacity planning. The shortage of parking spaces in many cities leads to severe traffic congestion and, in extreme cases, vehicular gridlock. In response to this issue, leading scientific centres around the world are actively working on the development of modern parking facilities and various systems, including both underground and above-ground solutions. In this regard, Georgia, and especially its capital, Tbilisi, is no exception.

Accordingly, our scientific and engineering team has set the objective of developing vertical parking systems for automobiles. To date, we have designed and patented four types of vertical parking systems, some of which have already been implemented in metal structures and installed. One such system is an 8-car vertical rotary parking system. In this system, vehicles move in both vertical and horizontal planes, enabling the creation of various configurations adapted to different landscapes and geographical conditions.

This system has allowed us to develop horizontal parking solutions for flat terrains, as well as hybrid and balcony-type systems for complex relief conditions. In total, four different variants have been developed. In addition, we have proposed an innovative approach in the design of vehicle lifts, which can effectively replace expensive ramp systems in multi-level underground parking facilities.

The four-space vertical parking system represents a carousel-type reversible mechanism that enables the accommodation of four vehicles within the area typically required for a single car by utilizing vertical space, thereby increasing land-use efficiency by a factor of three. This concept is described in our patents (Patent P 6322; Patent P 2021 7228 V; Patent U 2020 2052 Y; Patent P 2024 7702 P). The advantage of this design, compared to existing analogy, is that it reduces the need for complex vehicle manoeuvring during the parking process.

For the design of the four-space parking system, we aim to develop a mathematical model of the structure and to theoretically identify the most highly stressed components. This will allow us to reinforce these critical nodes during the design process and to validate the results through experimental studies. The modelling of the four-space parking system will serve as a foundation for the development of larger systems accommodating 6, 8, and 10 vehicles. The results of the research will be presented in the form of illustrative materials in the scientific paper.

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MBES-BASED GEOREFERENCING OF UNDERWATER STRUCTURE-FROM-MOTION 3D MODELS AND POINT CLOUD ACQUIRED USING AN ROV

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ABSTRACT

The application of photogrammetry in underwater environments, facilitated by the use of remotely operated vehicles, facilitates the acquisition of highly detailed three-dimensional point clouds and models of objects situated on the bottoms of water bodies. However, a significant limitation of this method is the lack of direct georeferencing of images and the absence of scale information, particularly in surveys conducted without ground control points, reference markers, or underwater positioning systems. The objective of this study was to develop and evaluate the potential of using multibeam echosounder (MBES) data as a spatial reference for a 3D model generated through underwater photogrammetry.

The study area was situated on Lake Leleskie, where a submerged automobile was identified and localized on the lakebed at a depth of approximately 8 meters using MBES data. Subsequent to its detection, a detailed underwater imagery was obtained using a remotely operated vehicle (ROV). This imagery was then used to reconstruct a dense photogrammetric point cloud and a realistic textured 3D model of the object. A photogrammetric point cloud was generated using the Structure-from-Motion (SfM) workflow, as evidenced by the collected images. Due to the absence of positional data associated with the images, the model was initially reconstructed in a local coordinate system devoid of an absolute scale. Subsequently, the photogrammetric point cloud was integrated with the georeferenced MBES point cloud through geometric registration, including scaling, rotation, and translation of the model.

The results of this study enabled the embedding of the detailed photogrammetric model of the submerged vehicle into a real-world coordinate system. This facilitated the assessment of consistency between the two datasets. The analysis was conducted using a comparative approach, incorporating point cloud comparisons, cross-sectional profiles.

The obtained results indicate that MBES data can serve as a valuable reference source for georeferencing and scaling underwater photogrammetric models, particularly in situations where the use of traditional control points is difficult or impossible.

The presented approach has the potential to be applied in the documentation of anthropogenic objects, the inspection of hydrotechnical infrastructure, underwater archaeology, the monitoring of seabed obstacles, and the creation of 3D model. The integration of underwater photogrammetry and MBES facilitates the combination of high-resolution optical reconstruction with georeferencing.

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METHODS OF MEASUREMENT AND AVAILABLE DATA FOR THE ENVIRONMENTAL ASSESSMENT OF STREETS IN THE CITY OF BRNO

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ABSTRACT

The paper focuses on an overview and critical evaluation of methods and available data used for assessing the environmental quality of streets within the city of Brno. The aim is to identify which data sources and analytical approaches are applicable at the city-wide scale and to define their limitations when applied to the detailed assessment of specific streets.

The research combines large-scale datasets, such as thermal maps of the city of Brno, mobile operator data describing the use of public space, and geographic data related to greenery and urban structure, together with the authors' own field measurements. The field research includes measurements of air and surface temperatures within defined time intervals, as well as mapping of the physical characteristics of streets.

The methodology is based on comparing different spatial scales, ranging from aggregated city-wide datasets to detailed analyses of individual streets. Particular attention is paid to the accuracy, explanatory value, and transferability of individual methods in evaluating microclimate conditions, the presence of greenery, and the actual use of public space.

The aim of the paper is to formulate a comprehensive methodological framework for evaluating the environmental quality of streets, linking available large-scale datasets with detailed field research. The results contribute to a more effective use of existing data sources in the planning and assessment of residential urban environments.

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MOBILE VIDEOGRAMMETRY AS A LOW-COST TOOL FOR RAPID 3D SPATIAL DOCUMENTATION

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ABSTRACT

Videogrammetry represents an accessible method for creating spatial models of objects, terrain, and the built environment. This article focuses on verifying its practical applicability in geodetic practice, particularly in terms of data collection speed, cost efficiency, technical requirements, and the quality of the resulting spatial outputs. Compared with laser scanning or professional photogrammetric systems, smartphone-based videogrammetry can offer a simple and operative method of documentation. However, its use must be assessed with regard to accuracy, the method of georeferencing, and the stability of the generated point cloud.

The research is based on three model tasks representing possible scenarios of use in geodetic and documentation practice: surveying underground spaces, determining cubature, and creating a vehicle model for further 3D processing, for example for 3D printing or digital modelling. In all cases, the same device was used, an Android-based Google Pixel 8a smartphone, together with the same video acquisition procedure and the same processing software, 3Dsurvey. The created point clouds were georeferenced using control points. For the underground spaces, a control point field measured by a total station was used, while for the vehicle model and cubature calculation, the control points were determined using GNSS. For the projects using GNSS, an RTK GNSS device was also used, continuously measuring during video acquisition.

The individual outputs were compared with reference models obtained by laser scanning. The evaluation focused mainly on model completeness, point cloud density, local deformations, geometric stability, and the practical usability of the results. The results show that videogrammetry enables rapid data collection with minimal costs and can serve as a suitable supplement to standard geodetic technologies. Laser scanning provides more accurate and technically robust outputs, but it is also more expensive and operationally demanding. Therefore, videogrammetry performed using a common smartphone may be suitable for rapid documentation, approximate cubature calculations, and 3D model creation in cases where the highest accuracy requirements are not necessary. This article contributes to the optimization of geodetic method selection and demonstrates the strengths and weaknesses of a low-cost videogrammetric workflow.

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MONITORING THE WATER QUALITY AROUND THE IRRIGATION ARRANGEMENTS

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ABSTRACT

The paper aims to identify and describe measures taken to observe the quality of water sources located around local irrigation systems. The use of water from surface or underground sources for irrigation applications may involve qualitative deterioration of shallow groundwater bodies.

The use of water from surface or underground sources for irrigation applications may involve qualitative deterioration of shallow groundwater bodies. This is the reason why in the approval and authorization procedures for irrigation projects, regulations are imposed that aim to systematically monitor the impact on the groundwater environment in the investment area or irrigation area.

Most often, this is possible by performing piezometric drilling for ecological observations, from which the relevant technical parameters for the designer, beneficiary and builder are highlighted.

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MULTI-PERFORMANCE ASSESSMENT OF PORTLAND COMPOSITE CEMENT MORTAR WITH CLASS F FLY ASH

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ABSTRACT

The cement industry faces increasing pressure to reduce clinker consumption and utilize industrial by-products more efficiently. This study investigated the mechanical, internal-quality, and waste-utilization performance of Portland Composite Cement (PCC) mortar incorporating Class F fly ash (FA). Five mixtures containing 0%, 10%, 20%, 30%, and 40% FA as a mass replacement for PCC were prepared. The water-to-binder ratio was adjusted from 0.534 to 0.620 to maintain a constant flow of 190 mm. Cubic specimens measuring 50 × 50 × 50 mm were tested at 7, 28, and 90 days using the point load test and ultrasonic pulse velocity (UPV). One-way ANOVA and Tukey's HSD test were applied to the 28-day results, while Waste Diversion Rate (WDR) and Waste Mechanical Performance Index (WMPI) were used to assess waste-utilization efficiency. Point load strength and UPV increased with curing age for all mixtures. At 90 days, the 10% FA mixture achieved the highest point load strength and UPV, reaching 1.150 MPa and 3732.1 m/s, respectively, exceeding the control values of 1.011 MPa and 3419.2 m/s. At 28 days, FA replacement significantly affected point load strength and UPV, with p-values of 0.016 and 0.006, respectively. Tukey's HSD showed that mixtures containing up to 30% FA remained statistically comparable to the control, whereas 40% FA caused significant reductions. WDR and WMPI increased continuously with FA content, reaching 9.11% and 0.0829 at 40% replacement. Overall, 10% FA provided the best long-term performance, while 30% FA offered the most balanced combination of engineering performance and waste utilization.

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NAVIGATING DIGITAL TRANSFORMATION: A REGIONAL OVERVIEW OF BIM INTEGRATION IN CENTRAL EUROPEAN ARCHITECTURAL CURRICULA

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ABSTRACT

Introduction: The digital transformation of the architecture, engineering, and construction sector has established new benchmarks for project delivery, emphasizing information management, open data exchange, interdisciplinary coordination, and compliance with international standards such as ISO 19650. Higher education institutions across Central Europe are increasingly expected to update their study plans in response to these shifts. However, within the post-socialist educational context of the Visegrád region, the integration of Building Information Modelling (BIM) into architectural education remains uneven and is shaped by institutional, curricular, and accreditation-related barriers.

Objectives: The objective of this paper is to provide a regional overview of the structural challenges and current tendencies influencing BIM integration within architectural curricula across selected Central European countries, with particular attention to the Visegrád context. The paper aims to identify overarching institutional and accreditation-related barriers that complicate the transition from traditional digital representation toward integrated construction information management.

Methods: The study uses a qualitative descriptive approach based on a high-level comparative review of secondary sources, national educational frameworks, publicly available study plans, and institutional accreditation-related materials. Rather than producing individual institutional rankings, the analysis focuses on identifying recurring systemic patterns in curriculum structure, digital skills development, and institutional readiness for BIM-based education.

Results: The preliminary review highlights several shared structural barriers across Central Europe. BIM is frequently positioned within technical, CAD-related, or software-specific courses rather than developed as a vertically integrated architectural methodology. The analysis also indicates that national digital construction strategies and increasing industry adoption do not automatically translate into coherent university curriculum reform. This gap is partly linked to rigid accreditation procedures, limited interdisciplinary teaching structures, and the slow adaptation of architectural curricula to information-management-based workflows. Although isolated initiatives are visible at selected institutions, especially at Master's level, a consistent regional approach to BIM-oriented architectural education remains underdeveloped.

Conclusion: The paper concludes that addressing the digital gap in Central European architectural education requires a systemic transition from software training toward integrated information management methodologies. Flexible, regionally sensitive curriculum guidelines aligned with European BIM frameworks could help architecture faculties modernize their study programs without losing their institutional and cultural specificity. The regional overview offers a foundation for future cross-border curriculum alignment and more detailed comparative research on BIM education in Central Europe.

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NEW TECHNOLOGIES FOR OCCUPANT BEHAVIOURAL DATA ACQUISITION TO ENHANCE ENERGY EFFICIENCY: A SYSTEMATIC REVIEW

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ABSTRACT

In today's world, the construction industry plays a pivotal role in the industrial and economic landscape and has a profound impact on the quality of life and the environment. It is widely recognised that buildings account for around 40% of primary energy consumption in many countries. In addition, the onset of industrialisation, urbanisation, population growth and climate change has led to a concomitant increase in demand for energy and more comfortable indoor environments. The construction industry therefore has an important role to play in meeting the challenges of the current energy crisis. Consequently, the construction industry must address the current energy crisis by designing new buildings to sustainability standards and renovating existing buildings to provide healthy living spaces with minimum energy consumption and maximum occupant comfort. In this context, building simulation has emerged as a powerful tool to address performance challenges throughout the building lifecycle, from design and construction to operation and retrofit. Simulations use a range of parameters, including building design, structural characteristics, climate projections and energy systems, to predict energy consumption patterns. However, the accuracy of these predictions is dependent on occupant behaviour, a multifaceted aspect that is inherently difficult to predict and subject to dynamic change. The impact of evolving intelligent technologies on the modelling of occupant behaviour is profound. These technologies provide opportunities for predicting and modelling occupant behaviour, which in turn facilitates the calculation of a building's energy performance and plays a significant role in improving energy efficiency. The main objective of this research is to examine the evolving landscape of intelligent technologies used in building energy simulation and present a comprehensive analysis of their applications. It also aims to provide a comprehensive and up-to-date synthesis of research that offers an evaluative perspective on the state of occupant behaviour modelling in the context of building energy simulation, particularly in light of the rapid pace of technological innovation. This review systematically searched the Scopus and Web of Science databases for the period 2014–2024; following the PRISMA protocol, 52 studies were retained for narrative synthesis, of which approximately 71% were published after 2020, indicating a rapid intensification of research at the intersection of building simulation, occupant behaviour and smart technology.

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NONLINEAR DYNAMIC RESPONSE SENSITIVITY OF OFFSHORE WIND TURBINES UNDER COUPLED AERO-HYDRO LOADING

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ABSTRACT

Offshore wind turbines operate in harsh marine environments characterized by turbulent winds, irregular waves, and strongly coupled aerodynamic, hydrodynamic, and structural interactions, leading to complex nonlinear dynamic responses. Variations in structural and environmental parameters can further alter system behavior by shifting natural frequencies and modifying response amplification. This study examines the nonlinear dynamic response sensitivity of the NREL 5 MW OC3 monopile offshore wind turbine under combined aero-hydro loading using fully coupled OpenFAST simulations. Five normalized tower stiffness levels (0.7, 0.85, 1.0, 1.15, and 1.3 EI) are considered under turbulent wind and irregular wave conditions at 6, 12, and 18 m/s, representing below-rated, rated, and above-rated operating regimes. To isolate the effect of tower stiffness, all other model parameters, including hydrodynamic coefficients and control settings, are kept constant, yielding a total of 15 simulation cases. Structural response is evaluated using time-domain metrics, including RMS and peak tower-top displacements in the fore-aft (FA) and side-to-side (SS) directions, together with tower-base bending moment. Frequency-domain analyses, including Fast Fourier Transform (FFT) and Power Spectral Density (PSD), are employed to identify dominant frequencies, spectral energy distribution, stiffness-induced frequency shifts, and potential resonance proximity. The results show that tower stiffness strongly influences tower-top displacement, particularly in the FA direction, whereas tower-base bending moment exhibits comparatively limited sensitivity. The most pronounced stiffness effects occur at the rated wind speed of 12 m/s, where RMS FA displacement decreases from 0.590 m at 0.7 EI to 0.381 m at 1.3 EI, corresponding to an approximate 35% reduction. Frequency-domain results further indicate that increasing stiffness generally shifts dominant response frequencies to higher values and redistributes spectral energy. At rated operation, significant response energy is concentrated in low-frequency excitation bands, with FA response occurring near the 1P region, suggesting increased resonance proximity. Overall, this study highlights the role of tower stiffness in governing the nonlinear dynamic behavior of monopile-supported offshore wind turbines under realistic coupled environmental loading. The findings underscore the importance of accounting for stiffness-dependent frequency shifts, displacement amplification, resonance proximity, and multi-frequency response characteristics in the structural performance assessment, fatigue evaluation, and design of offshore wind turbine towers.

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NUMERICAL MODELING OF A FRAGMENTED MEDIUM WITH LABORATORY MEASUREMENTS WITH USING DIGITAL IMAGE CORRELATION

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ABSTRACT

Advances in measurement techniques make it possible to construct laboratory models using fragmented medium. Using a laboratory test setup consisting of a box with a transparent partition, it is possible to create a model made of a fragmented medium and to obtain images of the side surfaces through the transparent partition. Analysis of the images obtained with the digital image correlation method allows for the measurement of deformations, displacements, and other parameters. This is a non-destructive, non-contact method in which parameter values are determined on the basis of changes occurring in the test specimen, e.g. due to the applied load. The determination of the deformation distribution at various points across multiple planes of a model of an aggregate layer enables advanced numerical analyses in order to identify the deformation parameters of the tested layer.

The article presents an analysis of a numerical model of a fragmented medium based on laboratory research. An unbound aggregate mix with a 0/31.5 particle size distribution, produced from granite rock, was used. Compacted aggregate, without any additives, exhibits the contrast required in the digital image correlation method for creating a surface model. In the tests, a specially designed box with a transparent partition was used, and the deformation values were determined through tests with digital image correlation. The layered model was loaded with a hydraulic cylinder, using three pressure levels. Using the parameter values obtained from the laboratory model under test, a backward analysis was carried out to estimate the parameters in the numerical model

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OBSERVED ROAD CHANGES ON A SECTION OF A HIGH EMBANKMENT IN THE AREA OF MINING DEFORMATIONS

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ABSTRACT

The exploitation of hard coal in Poland significantly contributed to the change of the terrain. Objects located on a deforming ground are subject to, among others, displacements, deformations, and ultimately damage. This creates a problem with their use. The effects of mining deformations can significantly change the functional properties of objects, including linear objects intended for vehicular traffic. Particularly important is the risk of a significant reduction in pavement durability, resulting from the deterioration of the mechanical properties of the pavement base and structural layers built on it. The significant importance of linear structures, including those exposed to mining impacts, necessitates periodic monitoring. Data obtained on the technical condition of road surfaces, along with information on vehicle traffic, are a crucial element used in the road management process, including determining the need and extent of protection against excessive damage.

This article presents the results of tests and observations conducted on the road surface, which runs primarily on an embankment section, in an area affected by mining activity. Black, unburnt coal shale was used to construct the embankment. The embankment was reinforced with geomattresses at its base and in its core. It is worth noting that the observations covered a period of 18 years, and the mining operations performed should be considered intensive due to the total subsidence of the terrain exceeding 9 meters.

The scope of research and observations included, among others, a visual assessment of surface damage and geodetic measurements enabling the calculation of terrain deformation indicators.

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OPTIMIZING ROOF GEOMETRY FOR ENERGY-EFFICIENT AND CLIMATE-NEUTRAL HOUSING IN GERMANY: COMPARATIVE BUILDING PERFORMANCE SIMULATIONS OF MULTISTOREY BUILDINGS WITH MONO-PITCHED AND GABLE ROOFS

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ABSTRACT

To achieve climate neutrality by 2045, German residential architecture must evolve beyond established conventions that no longer meet contemporary demands for energy performance, solar optimization, or spatial efficiency. Roof geometry fundamentally determines heat loss, photovoltaic electricity generation, daylight penetration, and interior volume utilization. Surprisingly, rigorous comparative analyses of mono-pitched versus gable roof configurations under Central European conditions remain scarce. Despite their prevalence in new multifamily construction—driven largely by regulatory path dependency and aesthetic tradition—conventional gable roofs frequently generate wasteful attic spaces, unnecessary material consumption, and suboptimal solar exposure. This research addresses that analytical void by systematically evaluating how a mono-pitched roof compares to a conventional gable roof when all other variables remain constant.

Two representative multifamily buildings served as the basis for comparison. Both share an identical footprint of 18 by 9 meters, rise through three stories, and enclose 1524.2 cubic meters. The gable-roof variant features a symmetric 40-degree pitch with ridge at 11.29 meters. Its counterpart employs a mono-pitched geometry sloping southward at 10 degrees, with eave heights of 10.20 meters north and 8.61 meters south. Each building incorporates contemporary low-energy standards: high-performance envelopes, heat pumps, and heat-recovery ventilation. Building performance simulations drew upon Typical Meteorological Year datasets for three climatically distinct German locations—Kiel, Schweinfurt, and Rosenheim. Indicators included net operational energy balance, photovoltaic yield, overheating frequency, daylight autonomy, useful illuminance, and usable floor and wall areas.

Results consistently favor the mono-pitched configuration. Across all simulated climatic zones, it generated 22–27 percent more annual photovoltaic energy per installed kilowatt-peak. Net operational energy balances turned positive for the mono-pitched variant everywhere, whereas the gable-roofed building hovered near neutrality. Daylight availability remained comparable, though the mono-pitched design recorded slightly fewer overheating hours.

Most consequential from a development standpoint, the mono-pitched configuration liberated substantially more occupiable space. Floor area exceeding two meters in height increased by approximately 11 percent, while usable wall surface above one meter grew by 14 percent. These gains arise because the uppermost story terminates in a full-height vertical wall combined with a gently sloping ceiling—contrasting sharply with the gable's steep pitches that render significant perimeter portions unusable.

Additional sensitivity analyses tested east and west orientation of both buildings. While, for the mono-pitched roof, photovoltaic output diminished 10–15 percent relative to south-facing alignment, performance still exceeded the gable's mixed-orientation average. Spatial efficiency improvements persisted irrespective of orientation, and net energy balances remained superior or comparable for the mono-pitched building across all directional scenarios.

These findings challenge deep-rooted regulatory preferences for symmetric roof forms. The evidence demonstrates that mono-pitched geometries can simultaneously advance energy performance, enhance solar harvesting, and expand usable volume—without compromising comfort. Such outcomes bear directly upon housing affordability, developer profitability, and decarbonization economics. Consequently, this study invites fundamental reconsideration of roof-shape restrictions and positions geometric optimization as a performance-driven variable in climate-responsive design. Subsequent research will extend to life-cycle assessments, material efficiencies, and additional roof typologies.

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PARAMETRIC STRUCTURAL DESIGN OF STEEL AIRCRAFT MAINTENANCE HANGARS COMPLIANT WITH EUROCODE 3 PROVISIONS

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ABSTRACT

Metal airplane maintenance hangars are essential infrastructure within modern aviation facilities, as they provide secure parking, repair capabilities, and operational preparedness for a wide range of aircraft. These structures play a critical role in safeguarding aircraft from adverse environmental conditions such as heavy rain, strong winds, extreme temperatures, and ultraviolet radiation, all of which can negatively impact aircraft performance and longevity. The geometry and the required technical characteristics of steel hangars can be precisely determined in accordance with established engineering standards and regulatory requirements, ensuring both safety and efficiency. A steel structural framework for a fighter aircraft maintenance hangar is typically designed in strict compliance with applicable regulatory standards, such as the Bi-SC Directive 085-005. The structure usually adopts a rectangular configuration, consisting of a sequence of primary frames positioned at regular intervals. These frames are interconnected through secondary structural elements, including cap beams and bracing systems, which enhance overall stability and load distribution. The main load-bearing components include purlins, secondary beams, and front columns, all of which contribute to the structural integrity of the hangar. A crucial phase in the structural analysis involves accurately determining the loads acting on the hangar. These loads include dead loads, live loads, wind loads, and seismic actions, and they are calculated in accordance with Eurocode 1 and Eurocode 8. The evaluation of different design scenarios and combinations is carried out following the principles outlined in Eurocode 0. The structural assessment and dimensioning of the steel hangar are typically performed using advanced analysis software such as SAP2000, ensuring precision and reliability, while the design itself adheres to the requirements of Eurocode 3. Furthermore, parametric analyses are conducted to investigate the influence of various design parameters. These include the support conditions of the primary frames, alternative modeling approaches for purlins and secondary beams, reductions in effective buckling lengths, and modifications to the roof geometry. This work ultimately aims to identify the most efficient and optimal structural solution, while highlighting how different design choices can significantly affect the performance and behavior of the initially proposed structural system.

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PARETO-BASED OPTIMIZATION FRAMEWORK FOR THE LOCATION-ALLOCATION OF URBAN EMERGENCY INFRASTRUCTURE

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ABSTRACT

Urban infrastructure (e.g., public transportation, medical services, emergency services, education facilities) is a driver and reflection of the quality of life in cities. Its provision will either enhance or jeopardize specific areas of them. The inclusion of this infrastructure in urban planning seeks to satisfy diverse objectives that may or may not conflict, and it is conditioned by the availability and management of various variables (spatial, operational, social, or economic).

Numerical, mathematical, and computational methods have been employed to optimize site selection in decision-making. However, many of these methods converge on using a single objective to optimize or on considering only one or a few variables, such as distance and cost, without incorporating other types of indicators into their modeling. From a formal modeling perspective, decisions should be made considering multiple criteria simultaneously and exploring non-dominated solutions.

For this reason, the present study aims to establish areas of greatest impact—understood as those where infrastructure reconfiguration increases coverage levels and reduces average distances—in the location-allocation of urban infrastructure, specifically police stations as a case study. These areas are identified through Pareto fronts generated by the NSGA-II methodology, enabling the construction of various decision-making scenarios based on the relative weights assigned to each objective. The proposed optimization model is formulated with simultaneous objective functions aimed at minimizing weighted distances and maximizing population coverage. In addition, this framework incorporates geospatial analysis using geographic information systems (GIS), employing layers of population density, road network, and territorial distribution of demand.

Preliminary results show scenarios that result in significant improvements in spatial efficiency compared to the current system configuration. The multi-objective approach enables visualization of trade-offs among resource allocation, territorial equity, and operational performance, providing guidelines for scenario-based decision-making. Although the case study focuses on police stations, the proposed framework is replicable across different types of infrastructure, for integrated analysis of multiple infrastructures, and across different scenarios or geographic regions.

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PEAK HEATING DEMAND ANALYSIS AND TEMPERATURE-DEPENDENT LOAD CHARACTERIZATION FOR A SINGLE MULTIFAMILY BUILDING

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ABSTRACT

This paper analyzes the oversizing of heat substations in multifamily buildings by comparing normative models with actual operating data and the applicable tariff framework. In the context of EU ETS emission-related costs and the requirements of the Energy Efficiency Directive (EED) associated with the development of fourth-generation district heating (4GDH), precise determination of required thermal capacity is an important factor in economic optimization. The analysis was based on telemetry data from a representative heating year selected from the 2010–2025 observation period. Application of the 99th-percentile method showed that the 99th percentile of daily domestic hot water (DHW) demand is 39.5% lower than the contracted capacity. Daily DHW demand was evaluated over a 365-day period, while the space-heating response was characterized using a temperature-dependent power-law radiator model. The analysis also quantified the effect of linearization at reduced temperature differences and distinguished operational control thresholds from extrapolated thermal balance conditions. In the space-heating (SH) subsystem, comparison of a representative power-law radiator model (n = 1.33) with a linear model showed a temperature-dependent overestimation; at the illustrative normalized temperature difference $\Delta T/\Delta Tn = 46.7\%$, the relative overestimation is 28.59%. The empirical building heat signature exhibited an observed SH cut-off near +8 °C. For $T_{out} < 8$ °C, linear regression yielded $Q_{total} = 73.10 - 4.514T_{out}$ ($R^2 = 0.993$), while comparison with the empirical DHW baseline gave an extrapolated SH balance temperature of approximately +12.8 °C. These results distinguish an operational heating cut-off from the thermal balance temperature and support the use of measured load characteristics in predictive energy management (PEM), with model predictive control (MPC) as one possible implementation approach.

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PERFORMANCE ASSESSMENT OF SOLAR THERMAL SYSTEMS WITH HEAT STORAGE IN MULTIFAMILY BUILDINGS UNDER REAL CLIMATIC CONDITIONS

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ABSTRACT

This study evaluates the long-term performance of a solar thermal system coupled with thermal energy storage (TES) for a reference multifamily building in northeastern Poland using 14 consecutive years (2010–2023) of hourly PVGIS-SARAH3 meteorological data. The reference building comprises 16 dwellings and 48 occupants. Domestic hot-water (DHW) consumption was assumed at 50 L per person per day, with cold- and hot-water temperatures of 10 and 55 °C, respectively, and a lumped DHW distribution and storage efficiency of 70%. A south-facing flat-plate collector field with an active area of 70 m², tilted at 38°, and a 3500 L fully mixed thermal storage tank were adopted as the reference configuration. A sequential hourly energy-balance model was used to determine useful solar heat, auxiliary-boiler demand, excess solar heat, TES state, and solar fraction over 122,712 hourly time steps. Annual useful solar heat ranged from 40.51 to 45.53 MWh/year, with a multi-year mean of 43.46 MWh/year. The corresponding annual DHW solar fraction varied from 61.95% to 69.63%, with a mean of 66.43%. The final energy demand of the gas boiler ranged from 22.06 to 27.65 MWh/year, giving an interannual spread of approximately 5.58 MWh. Mean monthly solar fraction varied from 16.7% in December to 98.3% in June. The highest annual irradiation occurred in 2018, but this year did not provide the highest solar fraction; excess solar heat reached 4.25 MWh, demonstrating the importance of temporal matching between solar availability, DHW demand, and finite TES capacity. The hourly profile for 19 June 2023 illustrates short-term storage of daytime solar gains for subsequent evening DHW demand. Relative to the combined annual space-heating and DHW demand of approximately 152.0 MWh, the mean useful solar heat corresponds to an equivalent whole-building contribution of approximately 28.6%. The results show that continuous multi-year hourly climatic series provide information on interannual variability, auxiliary-energy demand, and storage-limited solar utilization that cannot be obtained from a single representative year.

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PERSISTENT BY DESIGN: A SYSTEMATIC LITERATURE REVIEW OF THE DETERMINANTS OF BUILDING LONGEVITY

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ABSTRACT

Introduction: The building sector faces a fundamental contradiction: while ambitious climate targets demand substantial emission reductions, demolition and new construction remain dominant practices. In Germany alone, approximately 14,000 buildings are demolished annually, contributing significantly to resource depletion and waste generation. At the same time, the sector repeatedly fails to meet its emission reduction targets. Longevity therefore emerges as a critical strategy at the intersection of architectural design, circular economy, and heritage conservation. Extending the life of buildings reduces material throughput, preserves embodied energy, and strengthens cultural continuity.

Objectives: This research aims to systematically review and synthesize existing literature on building longevity in order to identify the ecological, social, and economic factors that influence it. The objective is to clarify how longevity can be understood not only as a technical attribute but as a multi-dimensional design and management strategy. A further goal is to assess the current state of methods for measuring longevity and to identify research gaps relevant to architectural practice and conservation.

Methods: A systematic literature review will be conducted, focusing on peer-reviewed publications, policy papers, and theoretical contributions related to circular construction, adaptive reuse, life-cycle assessment, and conservation theory. The review categorizes findings into three interacting dimensions: ecological (resource use, emissions, material durability), social (adaptability, cultural value, behavioral acceptance), and economic (life-cycle costs, market dynamics, value retention). Particular attention is given to emerging approaches for quantifying longevity, including the concept of resource duration as proposed by Franklin-Johnson et al. (2016), and its applicability to building-scale systems.

Results: Preliminary findings indicate that building longevity is shaped by dynamic interactions between ecological innovation, economic pressures, and social transformation. Technological efficiency gains often become obsolete due to rapid innovation cycles. Market-driven redevelopment and land speculation undermine long-term use. Social change demands spatial adaptability, challenging static design paradigms such as “form follows function.” Circular construction and design-for-longevity strategies show long-term economic advantages when evaluated over the entire life cycle, despite higher initial costs. However, existing assessment tools primarily measure environmental burdens rather than the duration of material and spatial utility, revealing a methodological gap in evaluating systemic architectural longevity.

Conclusion: Longevity must be reframed as an integrated architectural strategy combining robust construction, spatial flexibility, cultural anchoring, and economic foresight. It represents both a design method and a conservation principle that bridges new construction and heritage practice. To enable a genuine building transition, standardized and scalable indicators for measuring architectural longevity are urgently required.

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PHYSICAL ENVIRONMENT'S ACCESSIBILITY OF UNIVERSITIES IN SLOVAK REPUBLIC FOR STUDENTS WITH SPECIAL NEEDS

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ABSTRACT

Accessibility of the higher education environment is a key prerequisite for equal access to education and full participation of all students, in accordance with adopted human rights instruments. The aim of the research, conducted from September 2025 to February 2026, was to comprehensively assess the current state of physical accessibility at Slovak universities – identifying existing barriers and proposing appropriate measures for their removal. The assessment focused primarily on teaching spaces, administrative offices, libraries, student dormitories, sports facilities, and catering establishments. A total of 143 buildings across 24 Slovak universities were evaluated. The evaluation employed a proprietary assessment tool – the Access Audit Checklist – which incorporates fundamental spatial requirements to meet the needs of students with specific disabilities, particularly those with mobility impairments, as well as visual and hearing impairments. The research was conducted within the framework of a grant from the Ministry of Education, Science, Research, and Youth of the Slovak Republic under Project 2.12: Support Measures (subproject: universities) for the preparation of the analysis entitled Identification of Accessibility in Higher Education Institutions 2025–2026.

The evaluation employed a bespoke assessment tool – an access audit checklist – incorporating fundamental spatial requirements reflecting the needs of students with specific needs, particularly those with mobility impairments, as well as visual and hearing impairments. Access audits were carried out through in situ inspections of university buildings, complemented by interviews with academic staff and students. For each building, a final access audit report was prepared, structured into three main sections: evaluation of independent mobility and usability, orientation and access to information, and safety, health risks, and evacuation.

In the second phase of the research, the results of the conducted access audits were analysed, and a comprehensive summary of identified barriers was compiled in a structured tabular format. This was followed by an analysis of recommended interventions, including an estimation of the anticipated financial costs required to eliminate the identified barriers.

The findings indicate that 62.9% of the assessed buildings do not meet the established accessibility criteria. Although previous building modifications have led to partial improvements, they often fail to create a comprehensively accessible environment that would enable students with specific needs to use the facilities independently. Therefore, it is essential to approach the removal of existing barriers in a systematic and holistic manner, with a strong emphasis on the application of universal design principles. Substantial financial support from the state is indispensable. The required investment has been estimated at 54,2 million EUR in order to establish an inclusive academic environment across all Slovak higher education institutions.

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PLANNING FOR WHOM: A REFLEXION ABOUT THE LATE EVOLUTION OF URBAN DESIGN AND THE ROLE OF ARCHITECTURE TEACHING

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ABSTRACT

Introduction: planning for whom should be a question on which it should be crucial to reflect. With the proliferation of cities and suburban areas we observe more and more mischaracterized monotonous urban spaces, what brings the need to rethink the main aspects of planning and its main objective, environment, cultural, social and historical context, local resources, climate, all these factors in prowl of a sustainable and consistent attitude, where the main purpose should be undoubtedly people.

Objective: this paper aims to review and reflect about what must be the main role of planning and how we, teachers, in the architecture program can sensibilize the students for such a great responsibility, which is to draw the space where the “I” gives place to the “other”.

Methodology: to review the genesis of rationalism and purism in architecture, the proposes of the Athens Charter, and the consequents reactions of postmodernism, in order to understand what shift must be done, behind theory and practice.

Results: the methodology implied a critical approach, where the cultural, social and political context are essential to create new attitudes and concepts, and where the sensibilization of the students to the question “planning for whom” is crucial.

Conclusion: sometimes it is necessary to learn from the last century’s models and experiences that showed not to be the better solution. We can create now the chance and the opportunity of doing things in the right way, thinking in the main purpose of planning, which is unquestionably people.

Further discussions: with all the technologies, and tools at our disposal, are we aware of the real goals of planning? Is the sophisticated data and information contemplating the well-being of people?

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PLANNING REGULATION FAILURES IN PROTECTED HERITAGE ZONES: THE CASE OF THE SALBEK CASTLE ESTATE, PETRIȘ, ROMANIA

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ABSTRACT

This paper identifies and critically analyses a series of urban planning regulation failures affecting the Salbek Castle Estate in Petriș, Arad County, Romania — a nationally protected heritage ensemble of the highest significance category under Romanian heritage law. These failures were identified through the preparation of a mandatory Zonal Urban Plan required for the estate's restoration and functional reconversion. The study is grounded in a systematic multi-criteria analysis of applicable Romanian urban planning and heritage protection legislation, correlated with the current General Urban Plan of Petriș commune (2014) and supported by historical cartographic and archival research spanning the late 18th century to 2022.

The paper documents four categories of critical regulatory failures. First, the protected ensemble is erroneously divided across two incompatible planning zones — one designated for public institutions encompassing the castle building, and another designated as green space encompassing the historic park and ancillary buildings — in direct contradiction with the legal criteria of functional and historical homogeneity, and with no foundation in the historical urban evolution of the site. Second, its buffer zone is incorrectly delimited, traced at approximately 90–100 meters from the ensemble boundary rather than the legally required minimum of 200 meters measured from the outer property limit, leaving the village cemetery, half of the historic public square, and a significant portion of the park outside the protected perimeter. Third, an unresolved juridical conflict derives from the misapplication of public green space legislation to privately-owned heritage land, registered as "courtyards and constructions," generating legal ambiguity that obstructs both conservation and development authorization. Fourth, the built-up area boundary is incorrectly delineated on the eastern side of the estate, effectively placing a portion of the registered private property outside the declared built-up area, compounding uncertainty about the applicable regulatory status of the affected land. Collectively, these failures render effective heritage protection and legitimate development authorization practically unachievable under the combined effect of the applicable legislative and urban planning instruments.

In response to these findings, the paper proposes a revised regulatory framework comprising: a single historic reference zone subdivided into four historically-grounded subzones; a dedicated urban planning unit for the entire ensemble; a corrected and cadastrally delimited protection zone; and a set of operative management recommendations addressing supplementary archaeological and architectural investigation requirements, adjustment of the built-up area boundary, and public-private partnership governance for heritage valorisation.

The study argues that imprecise and contradictory planning instruments not only fail to protect heritage assets but actively generate legal obstruction to legitimate conservation efforts. The conclusions have broader potential applicability to similar protected ensembles across Romania, pointing to the need for further comparative research on heritage planning frameworks at the European level.

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POINT CLOUD OPTIMISATION FOR SCAN-TO-BIM

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ABSTRACT

The increasing adoption of laser scanning technologies, computational methods, and Artificial Intelligence in 3D surveying and architectural digitisation has highlighted the need for automated approaches capable of managing and interpreting large point cloud datasets in support of Heritage Building Information Modelling (HBIM). This research presents the preliminary stage of a Scan-to-BIM workflow focused on point cloud optimisation and segmentation of the ISES social housing complex in Via Smaldone, Foggia (Italy).

The proposed methodology includes preprocessing steps aimed at reducing dataset complexity while preserving the geometric and morphological characteristics of the building. Several subsampling and noise-removal strategies were assessed to improve data quality and enhance subsequent computational tasks. The comparison showed that local geometric filtering techniques provide better preservation of façade details and geometric discontinuities than statistical approaches.

After the preprocessing stage, an automated segmentation procedure was developed in Python using the open-source library Open3D. The workflow employs an iterative Random Sample Consensus (RANSAC) algorithm to identify and extract dominant planar surfaces directly from the surveyed dataset. The implemented method enables the recognition of the main vertical façade components while excluding secondary elements and irregular geometries.

The results demonstrate the effectiveness of the proposed methodology in simplifying complex datasets and supporting the semantic interpretation of architectural features. The segmented point clouds provide a reliable basis for future HBIM modelling and morphological investigations, highlighting the potential of integrating automated extraction techniques and open-source computational tools for built heritage applications.

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POTENTIAL OF MULTIFUNCTIONAL CULTURAL INSTITUTIONS IN THE MEDIUM-SIZED CITIES: RELATIONSHIPS BETWEEN TYPOLOGICAL-OPERATIONAL MODELS AND URBAN STRUCTURE

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ABSTRACT

Introduction: Multifunctional cultural institutions represent an increasingly important component of public infrastructure in contemporary cities. In medium-sized cities, they frequently fulfil not only cultural functions, but also social, educational, and community roles. Their importance is closely connected to the urban context in which they are situated and to their capacity to contribute to the activation, continuity, and stabilization of urban structures and public life. Current research, however, predominantly focuses on metropolitan environments and iconic cultural buildings, while the relationship between multifunctional cultural institutions and the urban environment of medium-sized cities remains insufficiently explored.

Objectives: The research investigates the potential of multifunctional cultural institutions within the urban context of medium-sized cities. It focuses on the relationship between the typological structure of cultural institutions, their hybrid programme, and the surrounding urban environment. The aim is to identify spatial, typological, and urban principles that influence the ability of these institutions to support everyday urban life, activate public space, and contribute to the vitality and continuity of urban structures.

Methods: The research is based on a comparative analysis of selected case studies from the Central European context. The analysed examples include multifunctional cultural institutions situated in medium-sized cities with diverse urban and historical conditions. The analytical framework evaluates typological organization, functional hybridization, relationship to public space, spatial permeability, temporal intensity of use, and integration into the urban structure. The methodological approach combines perspectives from urban morphology, typological analysis, and the study of public and cultural infrastructure.

Results: The research identifies recurring spatial and typological principles that significantly influence the urban potential of multifunctional cultural institutions. The findings indicate that the relationship between cultural institutions and public space, the diversity and everyday accessibility of functions, permeability, and temporal continuity of use play a key role in their capacity to activate urban environments. The analysis also suggests that medium-sized cities require a distinct approach to cultural infrastructure compared to metropolitan contexts, particularly due to differences in urban scale, social intensity, and the role of public space in everyday urban life.

Conclusion: The research contributes to a deeper understanding of the relationship between multifunctional cultural institutions and urban structure in medium-sized cities. It formulates a set of urban and typological principles influencing the potential of these institutions within contemporary urban environments. The study expands the discussion on public cultural infrastructure beyond the framework of iconic architecture and metropolitan development and highlights the importance of context-sensitive approaches to cultural institutions in medium-sized cities.

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PREFABRICATED BUILDING REFURBISHMENT

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ABSTRACT

Achieving the EU's climate neutrality targets requires accelerating the pace of thermal refurbishment of existing buildings. It is essential to apply innovative refurbishment technologies that will enable high-quality, repeatable and cost-effective measures to be implemented, whilst minimising construction time and environmental impact.

This article compares conventional thermal insulation systems with modular, prefabricated systems. The comparison focuses on assessing construction speed, installation accuracy, scalability and the embodied carbon footprint. The comparison identifies prefabricated modular technology as the future of thermal refurbishment.

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PREVENTING COVID-19 THROUGH DESIGN SUGGESTIONS FOR THAI GOVERNMENT HOSPITALS WAITING AREAS

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ABSTRACT

This study aimed to create hospital waiting area design guidelines that can prevent the spread of infectious respiratory disease, COVID-19. The study was carried out at Nakornping Chiang Mai Hospital. The study was conducted using a two-step evaluation process. First, walk-through observations were performed at outpatient waiting areas of the hospital. Second, interviews with 55 participants (20 registered nurses, 27 patients and 8 patient families). Observation data underwent architecture planning analysis together with photographs. Interviews were transcribed and analyzed through content analysis. Observation showed that the hospital was overcrowded. The layout was designed without separation of waiting areas. The hospital waiting areas required separate waiting areas. Interview results showed participants' opinions towards the design of the waiting areas and how to prevent infectious respiratory diseases. Moreover, participants suggested directions of physical components that could contribute to preventing the spread of infectious respiratory diseases. This study aimed to create hospital waiting area design guidelines that can prevent the spread of infectious respiratory disease, COVID-19. The study was carried out at Nakornping Chiang Mai Hospital.

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PUBLIC LIGHTING AS A TOOL FOR SHAPING THE IMAGE OF THE CITY: A COMPARATIVE STUDY OF EUROPEAN APPROACHES

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ABSTRACT

This paper examines public lighting as a formative element of urban space and its perception. Light plays a key role in structuring spatial legibility, orientation, atmosphere, and the overall image of the city at night. It contributes to how urban environments are experienced and understood in everyday conditions.
The research is based on a comparative analysis of three European cities – Vienna, Copenhagen, and Amsterdam – which represent distinct approaches to the design and governance of public lighting. The study focuses on the relationship between types of public space, applied lighting strategies, and their spatial effects. Particular attention is given to how different lighting approaches influence the character of the night-time environment and its perception by users.

The methodology combines the analysis of strategic documents, field research, and visual evaluation of selected urban situations. The study also addresses perceptual aspects of space, including orientation, sense of safety, and atmospheric qualities.

The aim of the paper is to identify key principles that define the relationship between light and the character of public space, and to outline a framework for a more systematic approach to public lighting within the ongoing transformation of European cities.

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RECONSIDERING THE 15-MINUTE CITY IN POST-SOCIALIST URBAN CONTEXTS: THE CASE OF RZESZOW, POLAND

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ABSTRACT

Contemporary urban policies increasingly promote the concept of the 15-minute city as a model for sustainable, resilient, and human-centered urban development. However, the practical implementation of this idea in dynamically growing medium-sized cities in Central and Eastern Europe remains insufficiently explored. In many cases, urban transformation processes continue to prioritize transport efficiency, investment pressures, and spatial expansion, often marginalizing issues of accessibility, social inclusivity, and the quality of the urban environment. This paper offers a critical examination of the applicability of the 15-minute city concept using Rzeszow—one of the fastest-growing cities in south-eastern Poland—as a case study. The analysis draws upon the authors' prior research on inclusive urban design, accessibility of public and historic spaces, integration of green and blue infrastructure, and environmentally responsive architectural solutions. The study investigates how spatial accessibility, pedestrian connectivity, access to public services, elements of urban street furniture, and networks of green spaces shape the everyday functioning of urban structures. Particular attention is given to the relationship between sustainable urban transformations and the needs of vulnerable groups, including older adults and people with disabilities. The paper emphasizes that urban space should be shaped not only by functional considerations but also by aesthetic values, and it presents examples of street furniture that combine both qualities and can be effectively implemented in urban environments. The findings suggest that implementing the 15-minute city model in post-socialist medium-sized cities requires not only infrastructural change but also a redefinition of planning priorities toward more human-centered and socially equitable approaches. The case of Rzeszow highlights both the potential and the limitations of contemporary urban transformations in emerging regional urban centers. The paper contributes to the ongoing discourse on sustainable and inclusive cities by proposing a critical, design-oriented perspective that integrates environmental, social, and spatial dimensions of urban change.

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RECYCLING WITH BITUMEN EMULSION OF WASTE MATERIALS FOR ROAD CONSTRUCTION: AN EXPERIMENTAL ANALYSIS

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ABSTRACT

The valorisation and reuse of waste materials represent an effective strategy for improving the environmental sustainability of road construction, particularly when cold recycling techniques are adopted. Compared with conventional hot-mix processes, these technologies significantly reduce energy consumption and atmospheric emissions. Among the available approaches, the stabilization of aggregates with bitumen emulsion is widely employed, especially in the case of reclaimed asphalt pavement (RAP). Nevertheless, other industrial by-products waste materials can also be successfully reused within a Cold Central Plant Recycling (CCPR) framework.

This study presents the results of a laboratory investigation on bitumen emulsion bound mixtures designed for pavement base courses and characterized by an aggregate skeleton entirely composed of waste materials, namely reclaimed asphalt pavement (RAP), steel slag, coal ash and glass waste, combined in different proportions. The experimental program was structured in two main phases. First, a preliminary characterization of each waste material was performed, focusing on both physical properties and environmental compatibility, including toxicological aspects, in order to verify their suitability for reuse in road engineering applications.

In the second phase, a comprehensive mechanical characterization of the bitumen emulsion stabilized mixtures was conducted. The experimental testing program included indirect tensile strength (ITS) tests, indirect tensile stiffness modulus measurements performed at three temperatures (10°C, 25°C and 40°C), and repeated load axial tests carried out at 30°C to evaluate the mixtures' resistance to permanent deformation. In addition, indirect tensile strength tests were performed on water-conditioned specimens to assess the moisture susceptibility of the mixtures.

The results demonstrated satisfactory mechanical performance for several mixture compositions. Indirect tensile strength values at 25°C on dry specimens reached up to 0.44 MPa, while stiffness modulus values at the same temperature ranged up to approximately 3,000–4,500 MPa, depending on the mixture composition and testing conditions. The mixtures also exhibited adequate resistance to moisture damage, confirming the effectiveness of bitumen emulsion in providing cohesion and durability even when unconventional aggregates are used.

The measured mechanical properties were compared with the requirements specified in the main Italian technical specifications for bitumen emulsion bound mixtures used in pavement base layers. The comparison confirmed that the investigated materials meet the relevant acceptance criteria.

Overall, the findings indicate that RAP, steel slag, coal ash and glass waste can be effectively used as complete substitutes for natural aggregates in bitumen emulsion stabilized mixtures for pavement base courses, contributing to resource conservation and supporting circular economy strategies in road infrastructure engineering.

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REIMAGINING TIRANA'S GREEN CORRIDORS: URBAN TRAILS AS LANDSCAPE-BASED INFRASTRUCTURE FOR PUBLIC REALM TRANSFORMATION

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ABSTRACT

Considering Tirana's ongoing urban sprawl, new mobility systems are needed to support urban liveability, public health, and environmental performance. Under this perspective, the research argues that green corridors should be acknowledged as strategic urban infrastructure and not just as landscape leftovers. The Three Lakes Urban Trails project in Tirana serves as a case study to illustrate how implementing trails can transform accessibility, reinforce ecological continuity, and improve the performance of public spaces, all while fostering active mobility. The project focuses on trails because it recognizes the unique opportunity they present to simultaneously improve conditions for active mobility in a city where such safe networks for walking and cycling are rare, while stitching together fragmented green assets to create stronger spatial connections. The objective of this project assessment was to ascertain if its underlying logic could serve as a replicable planning model for landscape-driven urban regeneration. The study is based on qualitative document analysis of the project summary and the cooperation agreement between the Albanian-American Development Foundation and the Municipality of Tirana, complemented by an interpretive reading of the proposed alignment, route hierarchy, and design standards. Linked by linear connections free of obstacles based on safety principles, The Grand Park of Tirana will extend its continuity towards Farka lake and Dry lake area. Broken patches will then become an operative system. Besides offering greater spatial permeability through prioritizing pedestrians and cyclists' movement along intersection nodes, it also enhances the legibility of the overall environment for daily mobility. This project demonstrates how active-mobility infrastructure can offer planning opportunities beyond the trail itself by relieving recreational pressure on the urban edge, supporting local rejuvenation initiatives, and linking mobility with public realm quality. In conclusion, the study affirms that cases like this underscore how infrastructure sensitive to landscape can function as a strategic planning mechanism for promoting sustainable urban development. Its broader contribution lies in showing that green corridors can operate simultaneously as mobility systems, public-space frameworks, and ecological connectors, offering a robust framework for urban planning, transportation, and sustainability debates.

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RELATIONSHIPS BETWEEN MECHANICAL, RHEOLOGICAL AND CHEMICAL PROPERTIES OF REAL AND ARTIFICIAL RECLAIMED ASPHALT MATERIALS IN SCOPE OF THEIR COMPACTION METHODS

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ABSTRACT

The aim of tge study was to investigate the relationships between the properties of asphalt binders contained in reclaimed asphalt pavement (RAP) and the mechanical properties of cylindrical samples prepared and compacted from this RAP, as determined in indirect tensile strength tests. Positive verification and understanding of the mechanisms behind these relationships may contribute to the development of a new methods for assessing the quality and suitability of reclaimed asphalt for reuse in the production of asphalt mixtures for road pavements. The subject of the research consisted of four asphalt recyclates (RAP): two real ones obtained from milling reconstructed road pavements and two artificial ones produced in the laboratory from mineral-asphalt mixtures subjected to short and long-term laboratory ageing. The analysed RAP materials contained paving grade bitumen and polymer-modified bitumen. Sieve analysis of the reclaimed asphalt was performed, followed by extraction of the asphalt binder using an organic solvent. Separation of the asphalt binder from the solvent solution was carried out using the vacuum rotary evaporator method. The extracted asphalt binders were characterized in terms of chemical composition using Fourier Transform Infrared Spectroscopy (FTIR), their rheological properties were determined using a Dynamic Shear Rheometer (DSR) under dynamic loading in oscillatory mode and their basic properties were also evaluated (penetration at 25°C and softening point using ring and ball method). Samples for mechanical testing were produced from the reclaimed asphalt materials using two methods: with a Marshall compactor and a gyratory compactor. Three compaction temperatures were used: 50, 70, and 90°C. Indirect tensile strength tests were carried out in a universal testing machine equipped with a climatic chamber at 25°C. Based on the force-deformation curves, the following parameters were determined: indirect tensile strength, fracture energy (pre-peak, post-peak, and total), slope of the force-deformation curve in the post-peak part, and the Cracking Tolerance Index – CTIndex (expressed as a function of fracture energy, post-peak slope, and post-peak deformation). The effects of the compaction methods and compaction temperature on the mechanical performance of the RAP samples were evaluated and relationships with the binder properties were investigated. The obtained results suggest that the CTIndex parameter may be a good predictor of the properties of the asphalt binder contained in the reclaimed asphalt, however its results are significantly affected by the investigated variables. Confirmation of the thesis regarding the possibility of linking the mechanical properties of reclaimed asphalt (determined in a simple and quick-to-perform indirect tensile strength test) with the rheological and chemical properties of the asphalt binder contained therein allows for more detailed research in the future studies.

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RENOVATION OF A BIOLOGICAL REACTOR USING A THREE-LAYER METHOD BASED ON POLYUREA- A CASE STUDY FROM BYTOM ODRZAŃSKI

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ABSTRACT

The article describes the process and results of renovating the biological reactor in Bytom Odrzański using polyurea spray technology. The goal of the work was to protect the reinforced concrete structure from further degradation resulting from an aggressive chemical and moisture environment. Photo documentation and pH testing confirmed the presence of adverse operating conditions, justifying the application of a protective coating. A pull-off adhesion test was also conducted; its results confirmed the coating's high quality. Applying polyurea enabled the quick and effective restoration of the tightness and durability of the biological reactor structural surfaces.

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REPAIR COST STRUCTURE AND FAILURE PATTERNS IN WATER DISTRIBUTION PIPELINES

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ABSTRACT

In recent years, urban water distribution systems have become critical technical infrastructures whose reliable operation directly determines the continuity of water supply to consumers. One of the main factors disrupting this continuity is the occurrence of pipe and fitting failures, which require temporary shutdowns of pipeline sections and generate substantial repair costs. Water utilities therefore place strong emphasis not only on ensuring rapid and efficient failure removal, but also on understanding and managing the economic consequences associated with these operations. This study introduces a comprehensive methodology for analysing the costs of failure repairs in water distribution networks, enabling utilities to quantify both total and unit repair costs and to support long-term planning of maintenance and renewal activities. The methodology is based on a detailed decomposition of repair-related expenditures, including labour, materials, equipment operation, and additional operational costs such as site restoration and external service charges. The labour cost analysis accounts for factors such as excavation, reinstatement, groundwater management, and pipe flushing, all of which significantly influence total repair expenditure. Based on multi-year operational datasets, the approach uses failure intensity indicators to estimate the annual number of expected failures and combines these values with average repair costs to calculate cost intensity indices expressed in monetary units per kilometre of network per year. These indices allow consistent comparison of different pipeline sections with respect to diameter, material, and typical failure types, highlighting variation in both failure frequency and associated repair expenses. The results indicate clear relationships between pipe characteristics and repair costs. Larger-diameter pipes, especially steel and grey cast iron pipelines, exhibit significantly higher average repair costs than smaller-diameter pipes, mainly because of increased labour requirements and more complex repair procedures. At the same time, failure intensity varies across materials: corrosion-related failures are particularly costly in steel pipes, whereas mechanical damage dominates in polyethylene networks and is generally less expensive to repair. The methodology supports utilities in identifying economically justified interventions by comparing the cost of point repairs with the costs of rehabilitation or full replacement. For example, repair becomes economically unjustified when its cost exceeds a defined proportion of the rehabilitation cost or when the effective service life gained from repair is too short relative to expected performance. By combining economic indicators with long-term operational observations, the approach supports the planning of multi-year maintenance budgets, the evaluation of rehabilitation strategies, and the improvement of overall water supply reliability. The developed cost analysis framework is applicable to any water utility that maintains sufficiently detailed operational records and can serve as a practical decision-support tool for managing urban water distribution infrastructure.

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RESEARCH TOOLS FOR ANALYSING THE WALKING BEHAVIOUR OF OLDER PEOPLE IN URBAN PUBLIC SPACES

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ABSTRACT

Demographic data on the aging of the European population demonstrate an expanding scale, reflected in shifts in age structure leading to a larger proportion of older individuals (Demography of Europe). Currently, the modern concept of active aging is gaining traction, with age-friendly urban initiatives aiming to bolster this model by implementing interventions that improve quality of life, mental and physical well-being, and social participation among older adults. These efforts enable older adults to fulfil their potential and participate in society according to their unique needs and capacities (Han et al 2021; Foster and Walker 2015). Walking is a key and well-defined component of active ageing. However, when developing urban strategies to promote walking among older people, it is essential to have reliable assessment tools that combine indicators of safety, functional and aesthetic quality with aspects of accessibility and inclusivity. This article argues that combining existing research tools (such as the NEWS – Neighbourhood Environment Walkability Scale) with accessibility audits (such as the Universal Design Walkability Audit Tool) can serve as an effective means of implementing strategies aimed at increasing physical activity in the form of walking among older people. The aim of this article is to analyse existing walkability assessment tools, alongside accessibility audits and guidelines for designing accessible pedestrian spaces, and to present the results of research into the preferences and specific characteristics of older people's walking mobility. The article poses the following questions: What characteristics of the urban environment influence older people's walking activity? Which factors are most significant: infrastructure, accessibility or social factors? To what extent does the perception of the environment (NEWS) correspond to its objective assessment? Which urban planning strategies are most significant in increasing walking activity among older people?

The study employed a comparative analysis of available research tools, as well as observational studies and in-depth interviews in selected urban spaces. The results obtained have enabled the identification of key areas for action regarding accessibility solutions, improving road safety, proximity to services and public transport, access to green infrastructure, and strengthening the role of the neighbourhood in building pedestrian connections.

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RESILIENT SOCIAL INFRASTRUCTURE IN DISASTER CONTEXTS

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ABSTRACT

Social infrastructures—such as libraries, schools, universities, community centers, and parks—are essential spaces that support daily life, interactions, and the well-being of communities. These spaces foster connections, provide access to resources, and sustain collective activities, forming the basis of social capital. Their importance becomes particularly evident during sudden disasters, such as earthquakes, hurricanes, or pandemics, when communities rely on these spaces to maintain essential services and collective support. Social infrastructures assume a strategic role in these contexts, helping to sustain service continuity and community life even during emergencies. However, clear architectural definitions for designing resilient social infrastructures to support communities are lacking. This study examines how social infrastructures can strengthen neighborhood resilience, highlighting the benefits they provide and identifying the fundamental architectural requirements to ensure their effectiveness. The objective is to offer practical guidance and strategies for architects to design spaces capable of supporting community resilience even under sudden emergency conditions. The methodology is based on a review of the state of the art of social infrastructures and an analysis of case studies reported in the literature, documenting how they have operated in emergency contexts. This analysis allows for the identification of effective architectural strategies to ensure service continuity, social cohesion, and community well-being. The findings of this research define the architectural requirements necessary for community resilience: architectural identity, flexibility and adaptability of spaces, accessibility and inclusiveness, functional autonomy, integration with outdoor spaces, and structural safety. Implementing these principles transforms social infrastructures into strategic tools for Disaster Risk Management, reinforcing social capital and community resilience. The proposed strategies thus provide a practical guide for architects engaged in designing resilient, inclusive spaces capable of sustaining collective life even in disaster contexts.

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RESISTANCE OF AN FOAMED ASPHALT MIXTURE WITH HYDRATED LIME TO CYCLIC EXPOSURE TO WATER AND FROST

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ABSTRACT

Traditional mineral-asphalt mixtures are characterized by high production temperatures ranging from 165°C to 180°C. Consequently, their production requires large amounts of energy. Furthermore, the manufacturing process releases significant quantities of greenhouse gases, particularly CO_2. However, in light of global warming, efforts are being made to reduce the energy consumption of production processes and to protect the environment by lowering emissions of gases harmful to the climate. These trends favour new, sustainable technologies in road construction. New types of warm mix asphalt (WMA) and half-warm mix asphalt (HWMA) have been developed to meet current expectations. They are produced at lower temperatures, ranging from 100°C to –130°C. HWMA mixes are more effective, particularly those produced using water-foamed asphalt – Foamed Asphalt Mix. As these types of mineral-asphalt mixes are produced at such significantly lower temperatures, it is essential to ensure they have adequate resistance to the effects of water and frost. This issue is particularly significant in countries with a temperate climate, characterized by sub-zero temperatures during the winter.

The study utilized AC 8S asphalt concrete with water-foamed bitumen, which was modified with a 0.6% by weight addition of a surfactant (SAA). Additionally, to ensure that the Foamed Asphalt Mix AC 8S possessed the required resistance to climatic factors, hydrated lime was added in quantities of 0, 15, 30 and 45% by weight as a substitute for the limestone aggregate. The resistance of FAM to water and frost was assessed using the AASHTO T283 method. To ensure conditions more closely resembling those on the road, the resistance of FAM was tested after 1, 3, 6, 9 and 12 freeze-thaw cycles. It was found that a high level of resistance to moisture and frost was achieved with FAM AC 8S when 30% hydrated lime was used. The test results confirmed the suitability of FAM AC 8S for use in road construction.

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RESTORATION AND SUSTAINABLE VALORIZATION OF GERMISARA ROMAN THERMAL COMPLEX IN GEOAGIU-BAI SPA

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ABSTRACT

Thermal baths hold a special place in the culture of health and relaxation, having been appreciated since ancient times for their beneficial effects on both body and mind. In historic spa settlements, the integration of archeological heritage within active urban and recreational environments presents significant architectural and urban planning challenges, especially regarding heritage preservation policies, accessibility, and sustainable valorization. Moreover, the relationship between landscape, heritage, and architecture is especially important because built interventions must protect fragile archaeological layers while enabling contemporary public use. In this context, the Roman thermal complex of Germisara in Geoagiu-Băi represents a significant case, where archaeological value, balneological tradition, and tourism potential intersect.

The present study investigates the Germisara site through a multidisciplinary architectural and urban analysis framework. The research methodology combines historical documentation, field investigation, conservation assessment, legislative review, and spatial study of the wider park and adjacent spa infrastructure. It evaluates the physical condition of the archaeological remains, their relationship with neighboring buildings and circulation routes, and the constraints imposed by heritage protection regulations. On this basis, the study develops a conceptual architectural strategy for a complementary intervention outside the archaeological core, designed to support interpretation, access, and public engagement.

The results indicate that Germisara is an exceptional archaeological ensemble of national importance, but it remains underused and visually disconnected from the surrounding public realm. The existing ruins are highly vulnerable, the site is difficult to perceive from key points in the park, and the current spatial organization limits controlled visitation. The proposed response is a low-profile multifunctional center for history and archaeology, placed on the footprint of existing buildings to avoid invasive construction. Together with landscape reorganization, elevated pedestrian routes, and a controlled visiting sequence, the project creates a cultural focal point that strengthens the connection between the archaeological site, the spa park, and the thermal resort.

The study demonstrates that sustainable valorization of archeological heritage requires integrated architectural, landscape, and urban approaches to balance conservation requirements with contemporary needs. The Germisara case study highlights that such an objective can function not only as a preserved archaeological monument, but also as an active cultural and educational destination. By combining heritage conservation with landscape design and complementary public functions, the proposed intervention framework supports sustainable tourism, local identity, and phased regeneration of the spa center. It therefore offers a replicable model for integrating archaeological sites into living urban and resort environments

Corresponding Author: Diana Maria Stanciu

RESTORATION OF NON-PROTECTED RURAL ARCHITECTURE AS A TOOL FOR CULTURAL AND ECONOMIC SUSTAINABILITY: THE CASE OF LÚKY POD MAKYTOU

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ABSTRACT

The paper addresses the issue of restoring non-protected rural architecture as a tool for cultural and economic sustainability. It is based on the premise that, despite the absence of formal heritage protection, these structures represent a significant bearer of local identity as well as a potential driver of future development. The main objective is to formulate a methodological framework for restoration that enables informed decision-making regarding the extent of intervention, the form of adaptation, and the selection of appropriate functional use. The proposed approach is structured as a multi-stage process including analysis of the existing condition, evaluation of historical and architectural values, selection of an appropriate intervention model, development of the architectural proposal, and assessment of its sustainability. Key principles include reversibility of interventions, minimization of impact, a controlled relationship between new and original structures, and an emphasis on economic feasibility. The methodology is verified through a case study of the municipality of Lúky pod Makytou, where the adaptive reuse potential of selected historical structures is examined. The proposed architectural interventions demonstrate the capacity of restoration processes to activate public space, support community life, and stimulate local economic development. The paper contributes to the discussion on the values of so-called “non-heritage” structures and demonstrates that their sensitive restoration can represent an effective tool for the sustainable development of rural settlements.

Corresponding Author: Filip Bránický

RE-URBANIZING THE CITY FLOOR: PUBLIC SPACE REGENERATION OF TRG AUSTRIJE, SARAJEVO

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ABSTRACT

Public squares in many cities have gradually lost their original role, not because people no longer need them, but because vehicular traffic has increasingly occupied the space they once provided. In historic and high-density urban areas, this process often results in places defined by parking lots, traffic edges, and fragmented pedestrian routes rather than by a clearly articulated civic center. This article examines the potential for reclaiming and revitalizing underutilized public spaces through an integrated design approach that combines the restructuring of mobility patterns with spatial regeneration.

Trg Austrije is used as a case study to explore how the relocation of parking to underground levels can stimulate pedestrian activity and improve everyday mobility, thereby enhancing the overall functionality of public space. The research methodology includes a review of relevant literature, a detailed reading of the site, and a comparison with selected precedents, followed by the development of a design proposal. The findings suggest that removing surface parking, strengthening pedestrian connections, improving links to public transport, and adapting existing buildings contribute to a more active, legible, and identity-oriented urban space.

The proposal for Trg Austrije demonstrates that urban infrastructure does not necessarily have to compromise public life, provided that the project is guided by clear, people-centered priorities. From this perspective, the study argues that the reactivation of such spaces is not only feasible but also essential for improving everyday urban experience in many contemporary cities.

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REVIEW OF ANALYTICAL EXPRESSIONS FOR DESCRIPTION OF NONLINEAR STRESS-STRAIN DIAGRAMS

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ABSTRACT

It is known that a large part of engineering materials practically have nonlinear mechanical behavior, even at relatively low stress levels, i.e. the relationship between stresses and strains is nonlinear. Therefore, a more realistic analysis of the mechanical behavior of various materials and structures under load is associated with taking into account material nonlinearity. In addition, taking into account material nonlinearity is an essential prerequisite for a more complete use of the strength of the material and contributes greatly to the design of more economical structures and facilities. In practice, taking into account material nonlinearity means applying nonlinear physical laws connecting stresses and strains. In this regard, the issue of analytical description of the nonlinear dependence between stresses and strains in uniaxial tension or compression is of great importance. There are characteristic differences between the nonlinear behaviors of various engineering materials. Therefore, a considerable number of various nonlinear expressions for the relationship between stresses and strains have been proposed in the literature. This paper reviews the various analytical expressions for the aforementioned relationships. Both analytical expressions for relationships between stresses and strains that are nonlinear from the very beginning and expressions for relationships that have a linear initial section are presented. A specific type of relationship expressing strains as a nonlinear function of stress is also considered. A typical example of such a relationship is the Ramberg-Osgood law. A general type of approximating curve for a nonlinear relationship between stresses and strains is also presented. An approximation that is a combination of a power and trigonometric relationship is considered too. The use of cubic spline functions for approximating the stress-strain relationship is also described. The overview presented in this paper may be useful in analyzing structures and facilities taking into account material nonlinearity.

Corresponding Author: Victor Rizov

SEMI-AUTOMATIC IMAGE-BASED ALGORITHM FOR QUANTITATIVE EVALUATION OF PLASTIC SHRINKAGE CRACKING IN RESTRAINED CONCRETE

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ABSTRACT

Plastic shrinkage cracking is one of the most common early-age deterioration mechanisms affecting concrete elements exposed to intensive evaporation. The assessment of crack formation is typically performed according to ASTM C1579, which evaluates the susceptibility of concrete mixtures to restrained plastic shrinkage cracking under controlled environmental conditions. Although the standard provides a framework for crack evaluation, the measurement of crack width and crack development is still often performed manually, making the process time-consuming and potentially subjective. This study presents a semi-automatic image-based crack detection algorithm developed for the evaluation of plastic shrinkage cracking in concrete specimens tested according to ASTM C1579. The proposed approach was implemented in Python and combines grayscale image analysis with signal-processing techniques to determine crack width from digital images. The algorithm operates on brightness profiles extracted along user-defined measurement lines crossing the crack. First, a raw intensity profile is generated from a narrow horizontal band of pixels. The crack centre is then identified as the global minimum of the raw intensity profile. Subsequently, the first derivative of the profile is calculated and the crack boundaries are determined using the nearest local maxima of the gradient located on both sides of the detected minimum. The crack width is calculated as the distance between these boundary points. To improve robustness and eliminate false detections caused by surface texture, pores, shadows, or image noise, additional validation criteria were introduced. These include intensity-based threshold verification, implemented either as a fixed threshold or an adaptive threshold calculated as a percentage of the median background intensity, as well as a maximum admissible crack width criterion. The algorithm automatically generates annotated images and exports measurement results for further analysis. The proposed methodology was calibrated and validated using a series of images obtained from ASTM C1579 plastic shrinkage cracking tests. Different thresholding strategies and gradient parameters were investigated to identify the most reliable detection procedure. The final version of the algorithm demonstrated stable crack localisation and repeatable crack width measurements for a wide range of crack morphologies observed during testing. The calibration and validation results confirmed the applicability of the proposed algorithm for assessing crack widths in concrete specimens tested according to ASTM C1579. Nevertheless, further research is required to improve image acquisition procedures and image quality, which currently represent one of the main limitations affecting measurement accuracy. In particular, a low number of pixels representing the crack width may significantly reduce the precision of crack boundary detection and width estimation.

Corresponding Author: Szymon Skibicki

SHEAR CONNECTIONS WITH BEECH WOODEN DOWELS USING BIRCH PLYWOOD FITTED INTO CLT PANEL

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ABSTRACT

The use of wooden dowels in timber connections has been common practice for a long time. The development of steel fasteners such as nails, bolts and, more recently, wood screws has caused wooden dowels to be replaced in joints by metal fasteners or connectors. In many of these solutions, metal fasteners are essential. However, in certain structural connections in buildings, including those made from CLT, timber dowel joints can be a valuable alternative in many practical applications due to their compatibility with timber components and the ease with which they can be disassembled and reused. Therefore, an advantage of joints made using wooden dowels is the ability to easily recycle entire sections of the structure.

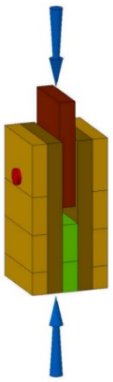


Fig. 1. View of a sample from the ‘SW’ series for shear under compression testing

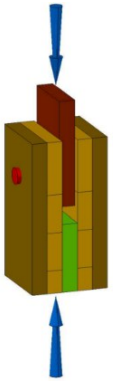


Fig. 2. View of a sample from the ‘SP’ series for shear under compression testing

Materials and methods

Experiments on the ‘SW’ and ‘SP’ series joints were carried out on five-layer CLT panel samples measuring 20 x100 x 200 mm. At one end of the models, in the middle of the panel were sockets 21 mm x 90 mm in order to embed birch plywood boards measuring 21 x 80 x 104 mm inside the CLT panel sample.

A CLT panel sample was connected to a plywood insert using a 22 mm diameter beech dowel. Whereas in the ‘SW’ series samples, the grain direction of the lamellas adjacent to the plywood sheets was parallel to the direction of loading, in the “SP” series samples, it was transverse to the loading axis. The shear strength of the beech dowels in the “SW” and “SP” series models was determined by compressing the models.

Results and discussion

Based on the results of the research were determined: the yield strength of the joint (F_y), the slip value of the joint at the point of yielding (v_y) and the modulus of elasticity of the joint (K_s). The joint yield strength (F_y, v_y) was determined at the point of intersection of two linear functions describing the variation

of the F-v relationship for two ranges: before and after joint yielding, as illustrated by the F-v relationship graphs for model (Fig. 3).

The module of elasticity K_s of the joint was determined as the tangent of the slope of the linear function prior to the joint yielding.

The results of strength tests on beech dowel joints in panels, taking into consideration two shear planes, are given in Tab. 1.

Tab. 1. Designation of the characteristic yield strength of the joint $F_{y,k}$

Lp.	**Serie**	Number of samples [pcs]	Yield strength of the joint F_y [kN]			Standard deviation s [kN]
			Average $F_{y,mean}$	Maksimum $F_{y,max}$	Minimum $F_{y,,min}$	
1	**SW**	8	**10,667**	13,933	8,665	1,73
2	**SP**	8	**9,748**	10,926	7,802	1,27

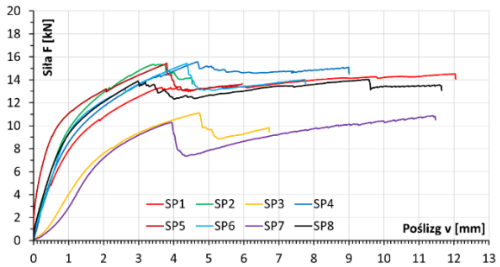


Fig. 3. F-v graphs for the 'SW' series models

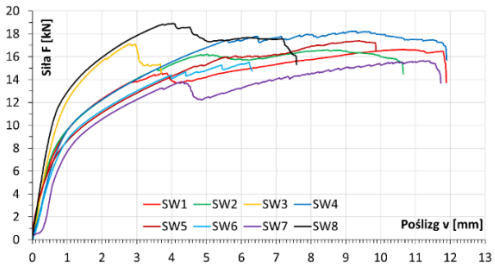
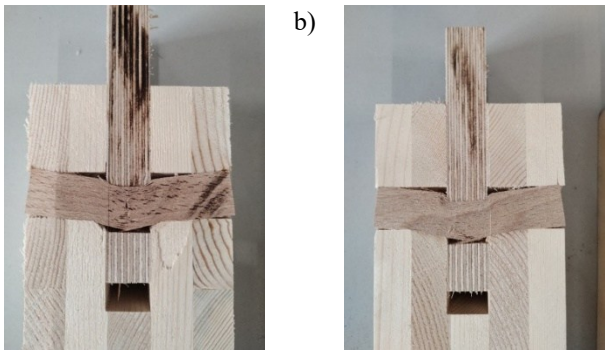


Fig. 4. F-v graphs for the 'SP' series models

a) b)


Fig. 5. Examples of damage in the samples series: a) „SW", b) „SP"

Based on the research and theoretical analysis, the following main conclusions can be drawn: wooden dowels can compete effectively with steel dowels in creating joints in timber structures; however, it should be remembered that the modes of failure may differ significantly from those of metal fasteners.

Corresponding Author: Agnieszka Janas

SILVER NANOPARTICLE-MODIFIED CEMENT COMPOSITES FOR ENHANCED DURABILITY OF SEWER INFRASTRUCTURE

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ABSTRACT

Sewer infrastructure is exposed to highly aggressive environmental conditions associated with elevated humidity, hydrogen sulphide emissions, and microbiologically induced concrete corrosion. Concrete structures used in sewer systems, manholes, pumping stations, and wastewater treatment facilities are particularly vulnerable to sulphate corrosion caused by microbial communities involved in sulphur oxidation processes. These phenomena lead to progressive degradation of cement-based materials, reduction of structural durability, and significant maintenance costs. Therefore, the development of cement composites with enhanced resistance to biological and chemical degradation remains an important challenge in sustainable civil engineering.

This study presents the investigation of novel cement composites modified with silver nanoparticles (AgNPs) stabilised using dextrin-based biopolymer additives. The developed material was designed as a multifunctional cement composite combining antimicrobial activity with improved workability and mechanical properties. The research focused on evaluating the behaviour of the developed composites under real operating conditions representative of sewer infrastructure.

Experimental mortar samples were prepared using Portland cement and standard quartz aggregate. Dextrin-stabilised colloidal silver nanoparticles were incorporated into the cement matrix as an admixture. Selected variants were additionally protected with a nanosilver surface coating. The prepared samples were exposed in situ for 24 months inside an industrial sewer manhole characterised by hydrogen sulphide concentrations reaching approximately 200–300 ppm. The investigated environment represented highly aggressive conditions promoting microbiologically induced deterioration of concrete.

After the exposure period, the samples were subjected to detailed microscopic and microbiological analyses. Scanning electron microscopy observations revealed significant differences between the reference samples and the nanosilver-modified composites. Conventional cement composites showed clear symptoms of sulphate corrosion, including surface degradation, exposed aggregate, and intensive biofilm penetration into the cement matrix. In contrast, the samples containing silver nanoparticles exhibited substantially lower degradation intensity, reduced surface deterioration, and limited microbial colonisation.

The obtained results demonstrated that the incorporation of silver nanoparticles effectively limited processes associated with microbiologically induced concrete corrosion. In addition to antimicrobial performance, the developed admixture positively influenced the workability and compressive strength of the cement composites. The proposed approach may provide a promising solution for improving the durability and service life of sewer infrastructure operating under severe biological and chemical exposure conditions..

Corresponding Author: Marta Sybis

SIMPLIFIED SEISMIC VULNERABILITY ASSESSMENT OF THE HISTORICAL CITY CENTER OF LUGOJ CITY, ROMANIA

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ABSTRACT

European historical cities, especially the ones located in Eastern Europe, are exposed to seismic risk due to the combined effect of local conditions, aging building stock, lack of proper consolidation work, insufficient seismic design knowledge at the time of construction, as well as the presence of valuable cultural heritage assets. Considering this context, the present paper illustrates a simplified seismic vulnerability assessment methodology applied to the historical center of Lugoj city, Romania. The aim of the research work is to support quick and simple urban-scale risk assessment procedures and future mitigation strategies. The methodology is focused on the identification and classification of the most vulnerable buildings within the investigated case study area, where most of the buildings are made in unreinforced masonry with lime, built during the late nineteenth and early twentieth centuries. The research work is based on several investigation tools, such as field surveys, archival documentation and visual technical inspection, to assess some key parameters such as the structural typology, regularity in plan and elevation, building materials, heights, irregularities, state of conservation and adjacent conditions. The results indicate a medium vulnerability in the area, slightly higher for the buildings that present an advanced state of degradation and lack of structural interventions when needed. Moreover, the presence of several architectural-artistic assets highlights not only the possibility of structural damages in case of an earthquake in the area, but also the possibility of substantial cultural and socio-economic losses. Eventually, the study demonstrates that simplified vulnerability assessment procedures can provide reliable preliminary information for decision-makers, especially in large urban areas where detailed and complex technical reports are limited by human resources, time, lack of technical documentation and financial constraints. The assessment framework represents a practical tool for local authorities, urban planners and conservation specialists involved in heritage preservation policies. Last but not least, the present paper presents a short set of recommendations for reducing the seismic vulnerability and increasing the prevention level..

Corresponding Author: Moundher Mouaki Benani

SMART CITIES IN PRACTICE: AIRPORT ADVANTAGES, CITIZEN-CENTRIC INNOVATION IN BARCELONA AND CIM

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ABSTRACT

In recent decades, metropolitan areas have undergone profound transformations driven not only by intensified urbanization but also by the Smart City paradigm. These dynamics affect both consolidated urban cores and suburban territories, reshaping centre–periphery relationships. In this context, this research analyses territorial transformations associated with the location of international airports as hubs of urban centrality. Such infrastructures play a pivotal role in territorial organization, altering the dynamics between central and peripheral areas.

The study examines the advantages of proximity between airports and urban environments, considering their strategic importance for accessibility, international connectivity, and urban competitiveness. Combining theoretical and empirical perspectives, it discusses how the functional integration of airports into the urban fabric enhances transport efficiency and strengthens cities' positions within global air networks. It begins by reviewing airport typologies and the territorial criteria guiding their location, highlighting their relevance to Smart City strategies. The methodological approach is grounded in a literature review, drawing on global examples such as Dubai and Singapore, as well as European cases including Barcelona and Copenhagen.

It continues with an analysis of the benefits for urban areas resulting from the influence of airport infrastructures. Although the literature in this field identifies a myriad of factors. The aim is to systematize the focus of the research on those considered most relevant worldwide. Accordingly, the intention is to explore in greater depth the advantages related to urban growth versus real estate speculation, issues centered on housing and demography, an aspect that ranks at the top of territorial policies, transport networks, accessibility and mobility, as these are crucial at the metropolitan scale. As well as territorial cohesion, a key aspect for the success of the transformations triggered by the International Airports localization.

Corresponding Author: Ana Virtudes

SOIL-STRUCTURE INTERACTIONS OF BUILDINGS DUE TO EARTHQUAKE ECITATIONS

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ABSTRACT

Soil-structure interactions are the subject of importance in the area of structural and geotechnical engineering. In designing buildings due to earthquakes, the support is normally assumed as fixed or hinged. In actual condition, the structures are supported by foundations through the interaction with the soils. However, much evaluation must be done as still many factors of the soil-structure interactions need to be observed. This paper discusses soil-structure interactions, where a single degree of freedom structure is used to evaluate the change of fundamental period and time history responses of the structures. Two models are utilized; the first model is when the interaction of structures and soils is modeled utilizes horizontal and rotational springs, while base structures is considered have no mass. The second model is when the interaction of structures and soils is represented by mass of the base, including horizontal and rotational springs as well as horizontal and rotational damping. Three soil conditions are evaluated in this paper, i.e., soft, medium, and dense soil. The results show that the increase of the fundamental period is more profound for soft soil compared to medium and dense soil. The increase in the period is almost comparable for the two models. The structure is then subjected to El Centro and Kobe ground accelerations. Similar soil conditions are also considered. However, simulations to recorded earthquakes show that the increase of periods does not mean that the peak time history response increases or decreases. For time history subjected to El Centro, the lowest response reduction compared to fixed structural support can be as low as 62.6% for medium soil, while the increase response can be as high as 328,7%. For Kobe ground acceleration, the lowest response reduction is 64% for dense soil, while the increase response can be as high as 147.8% for soft soil condition.

Corresponding Author: Theresia Lu Theopuspitasari, Yoyong Arfiadi

SPECIES COMPOSITION, STRUCTURAL CHARACTERISTICS, BIOMASS, CARBON STORAGE, AND ECONOMIC VALUE OF URBAN TREES: A CASE STUDY OF 15 TEMMUZ NATIONAL GARDEN, KAHRAMANMARAŞ, TÜRKİYE

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ABSTRACT

Urban trees are important components of green infrastructure, contributing to biodiversity conservation, climate regulation, and carbon storage. Quantifying the composition, structure, and carbon storage capacity of urban tree communities is therefore important for sustainable urban planning and climate change mitigation. This study evaluated species composition, diversity, structural characteristics, biomass, carbon storage, and the economic value of stored carbon in 15 Temmuz National Garden, Kahramanmaraş, Türkiye. A complete inventory of the tree community was conducted, and dendrometric variables, including tree height, crown width, diameter at breast height (DBH), stem dimensions, and bark thickness, were measured. Branch, leaf, and bark samples were collected, and biomass and carbon storage were estimated using the KARBİYOSİS (Carbon Storage and Biomass Calculation System) software. Species diversity and phytosociological parameters were assessed, and relationships between dendrometric attributes and carbon storage were examined using correlation and regression analyses.

A total of 525 trees representing 22 taxa, 19 genera, and 13 families were recorded. Native taxa accounted for 59.1% of the taxa and 77.1% of all individuals, while the Shannon–Wiener and Simpson heterogeneity indices were 2.43 and 0.867, respectively. Fraxinus angustifolia, Tilia cordata, and Platanus orientalis were the dominant taxa. The total aboveground biomass was estimated at 81.62 Mg, corresponding to 37.74 Mg C and 138.51 Mg CO_2. The economic value of stored carbon was estimated at 10,298.57 EUR based on the average 2025 European Union Emissions Trading System carbon price. Fraxinus angustifolia and Platanus orientalis made the largest contributions to total biomass and carbon storage. Carbon storage was significantly associated with tree structural attributes, with DBH emerging as the strongest individual predictor ($R^2 = 0.726$, $P < 0.001$). These findings demonstrate the measurable contribution of urban trees to biodiversity conservation and carbon storage and emphasize the importance of tree size, species composition, and the preservation of large trees in urban green space management. Integrating these attributes into planting and management strategies may enhance the long-term carbon storage and ecological performance of urban green infrastructure.

Corresponding Author: Mert Çakır

SPIRULINA-DERIVED PYROLYTIC BIO-OIL FOR CLIMATE-RESILIENT AND LOW-CARBON ASPHALT PAVEMENT

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ABSTRACT

Introduction: Climate change is accelerating the deterioration of road infrastructure through higher service temperatures, intensified oxidation, moisture exposure and more frequent maintenance demands. Asphalt pavements rely heavily on petroleum-based bitumen, and bitumen ageing can lead to increased stiffness, reduced ductility, weakened adhesion and lower fatigue resistance. Developing bio-based asphalt additives that can improve durability while reducing dependence on fossil-derived materials is therefore important for climate-resilient and low-carbon pavement infrastructure.

Objectives: This study investigates the potential of *Spirulina*-derived pyrolytic bio-oil as a sustainable modifier/rejuvenator for asphalt binders. The objectives were to identify an appropriate bio-oil dosage based on bitumen-aggregate adhesion performance and then evaluate its ability to mitigate ageing-related chemical and rheological deterioration.

Methods: *Spirulina* bio-oil was produced through slow pyrolysis and blended with unaged and aged bitumen binders. Pull-off adhesion tests were first conducted on unaged, short-term aged and long-term aged binders modified with 2%, 5% and 8% *Spirulina* bio-oil to determine the most suitable dosage. Based on the pull-off adhesion results, 5% *Spirulina* bio-oil was selected for further evaluation. Fourier-transform infrared spectroscopy was then used to assess functional group changes and oxidation-related indices, while dynamic shear rheometer time sweep tests were conducted to evaluate fatigue resistance of binders at different ageing levels.

Results: The pull-off test results showed that 5% *Spirulina* bio-oil provided better adhesion performance than 2% and 8% across unaged, short-term aged and long-term aged binders, indicating an optimum dosage for improving binder–aggregate bonding. FTIR results showed that *Spirulina* bio-oil contains oxygenated and aromatic-related functional groups that can interact with aged bitumen. The addition of 5% bio-oil reduced the sulfoxide index of aged binders, suggesting partial chemical restoration and degradation of ageing-related sulfoxide groups. Rheological testing further showed that 5% bio-oil improved the fatigue life of aged binders, particularly at moderate ageing levels, although the rejuvenation effect became limited under severe long-term ageing.

Conclusion: The findings suggest that *Spirulina*-derived pyrolytic bio-oil has potential as a bio-based asphalt modifier for improving adhesion, ageing resistance and fatigue performance of bituminous binders. The optimum dosage identified in this study was 5%, based on its combined adhesion and rheological benefits. This work supports the development of low-carbon and climate-resilient pavement materials using renewable microalgae-derived resources.

Corresponding Author: Lu Zhou

STABILIZATION OF A MASONRY BUILDING STRUCTURE USING HORIZONTALLY ORIENTED PRESTRESSING CABLES WITH LONG-TERM MONITORING OF THE MASONRY'S RESPONSE

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ABSTRACT

This paper describes the structural design for stabilizing a single-story masonry house using horizontally oriented prestressing cables. The building was damaged by cracks caused by volume changes in the foundation soil, which penetrated the walls and reached widths of up to 5 mm. Following successful stabilization with horizontally oriented prestressing cables, the long-term response of the masonry to the applied prestress was monitored using 500 mm-long measuring bases. Measurements were taken over a period of 10 years and showed that long-term prestress loss, with properly designed prestressing cable cross-sections, is within 20% of the applied prestressing forces.

The paper presents the prestressing design, structural details, and principles. It also describes the construction of the anchorage zones, the installation of substitute cable ducts, and crack injection. The response of the masonry is illustrated by measurement results obtained during prestressing and at various stages throughout the monitoring period.

The paper demonstrates the feasibility of this structural concept and, at the same time, the stability of the applied prestressing, which is often still questioned by some experts.

It may be beneficial for construction practice as well as for designers, as the principles and results presented are applicable to the stabilization of masonry structures in civil and residential buildings, as well as in historic structures. The described stabilization method could also be applied as a preventive reinforcement of structures against the effects of earthquakes.

Corresponding Author: Ladislav Klusáček

STRUCTURAL ASSESSMENT OF CHURCH OF THE BODY OF CHRIST IN JANKOVCE, SLOVAKIA

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ABSTRACT

This article focuses on the structural assessment of the Church of the Body of Christ in Jankovce, in eastern Slovakia, built in the 18th century, which was severely damaged by an earthquake in October 2023. The main objective of the structural survey was to identify and assess the severity of defects, primarily to determine whether the church should be preserved or demolished, and to propose appropriate restoration strategies for selected areas of the church based on the extent of their damage. The survey was conducted with the aim of eliminating any threat to human life or health, and in particular to significant cultural assets.

The report is based on a detailed on-site inspection of the church following the earthquake, focusing on the masonry structures of the nave and apse, the space beneath and on the gallery, and the tower. The assessment process combined visual inspection with basic diagnostic methods to evaluate the condition of the structures at the time.

Close attention was paid to the displacement of the vaulted structures and extensive cracks caused by the sudden ground movement. Structural defects and localized collapses were identified as critical issues requiring immediate attention. The survey established a systematic approach to classifying damage based on its severity and potential impact on structural stability.

The main findings include a proposal for urgent structural stabilization measures for the most severely damaged vaulted structures and the technical procedures for their implementation, as well as a proposal for further work on lower-priority sections or structures - particularly vertical wall structures - including the technical procedures for their restoration. The proposed protective measures have already been implemented on-site and were followed by a successful comprehensive restoration, the results of which are already being enjoyed by local parishioners.

Corresponding Author: Martin Poliak

STRUCTURAL ASSESSMENT OF THE RUINS OF STARHRAD CASTLE IN SLOVAKIA

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ABSTRACT

This article focuses on the diagnostics and structural assessment of the ruins of Starhrad Castle, a medieval fortification located east of Žilina on the right bank of the Váh River. The primary purpose of the research is to identify and evaluate the most common types of structural defects occurring in historic ruins, determine their causes, and propose an effective methodology for their diagnosis and classification according to severity. The study also aims to outline appropriate strategies for repair and conservation, taking into account both the technical requirements and financial constraints.

The research is based on a detailed on-site inspection of the castle remains, including masonry structures, the preserved tower, and remnants of the palace and perimeter walls. Special attention is given to typical deterioration phenomena such as cracking, material loss, weathering, biological degradation, and structural instability caused by long-term exposure to environmental conditions and lack of maintenance. The identification process combines visual assessment with basic diagnostic methods to evaluate the current condition of the structures.

The principal results highlight that the majority of defects are related to prolonged weathering, water infiltration, and vegetation growth, which significantly affect the integrity of the masonry. Structural discontinuities and localized collapses were identified as critical issues requiring immediate attention. The study further establishes a systematic approach to classifying defects based on their severity and potential impact on structural stability.

The major conclusions emphasize the importance of regular monitoring and a well-defined diagnostic procedure for historic ruins. A prioritization framework for repair interventions is proposed, balancing the urgency of structural issues with available financial resources. The article also underlines the necessity of ongoing conservation efforts, which are currently being implemented at the site, to preserve the cultural and historical value of Starhrad Castle for future generations.

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STRUCTURAL IMPACT OF EXTREME WEATHER EVENTS ON FLEXIBLE PAVEMENTS: A GPR AND LWD CASE STUDY IN PORTUGAL

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ABSTRACT

In recent years, Portugal has experienced an escalation in the frequency and severity of extreme weather events driven by climate change, notably through intensified precipitation and significant temperature fluctuations. In particular, a sequence of Atlantic winter storms affecting the Iberian Peninsula in early 2026 (including Storm Kristin and subsequent systems) produced intense rainfall and widespread flooding. These environmental stressors pose a critical challenge to the long-term resilience of national infrastructure, especially within the road network, where flexible pavements are predominantly utilised. The resulting structural damage has led to a marked reduction in pavement service life, escalating maintenance costs, and substantial socio-economic disruptions due to prolonged road closures.

This study investigates the structural degradation caused by such events, using this recent flood episode as a primary case study. The research focuses on a 6 km section of a major Portuguese motorway, with particular emphasis on a 2.0 km stretch that suffered total submersion during peak flooding for several days. To assess the extent of subsurface damage without destructive sampling, Ground Penetrating Radar (GPR) was employed, conducting seven longitudinal scans across the entire section to evaluate layer thickness, identify interlayer debonding, and assess the linearity of the pavement profile. Furthermore, Light Weight Deflectometer (LWD) tests were performed at multiple points along the hard shoulder to determine the elastic moduli in the most affected areas.

The results from the GPR measurements revealed a severe loss of structural integrity in the submerged sections, specifically highlighting significant loss of granular material base layer on the hard shoulder along the 2.0 km section. Data from the LWD tests corroborated these findings, indicating that the moduli increased progressively towards the pavement lane. The results obtained confirmed that the most affected area was the edge strip, up to 1.5 meter of shoulder, where the hydraulic action of the floodwaters induced the internal erosion of fines and aggregates from the granular base, leading to the subsequent failure (lack of support) of the bituminous mixtures courses.

As an immediate engineering solution, the diagnostic tools demonstrated that the fast lane (left lane) remained in good structural condition, allowing for its reopening under restricted traffic conditions. Conversely, the hard shoulder, compromised by the significant loss of the granular base and subsequent structural instability, required rehabilitation or full reconstruction before the motorway could return to its full operational capacity. This study underscores the necessity of integrating advanced non-destructive testing into climate-resilience strategies to facilitate rapid and data-driven decision-making for infrastructure recovery after extreme weather events.

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STRUCTURAL PERFORMANCE COMPARISON OF HYPERBOLIC PARABOLOID STEEL BAR SYSTEMS SUBJECTED TO ENVIRONMENTAL ACTIONS

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ABSTRACT

Curved roof systems composed of hyperbolic paraboloid (HP) modules have been increasingly adopted in structural engineering due to their distinctive aesthetic qualities and favourable load-bearing behaviour. This article continues the authors' research on the development of curved steel bar roof structures formed using modules based on hyperbolic paraboloid (HP) geometry. The study builds upon previous analyses investigating the influence of geometric parameters and bar-mesh topology on structural efficiency, considering only the self-weight of steel members and cladding loads. The primary objective of the current research was to verify previously identified trends for the most structurally efficient configurations, this time incorporating environmental actions such as wind and snow loads. The analysed models were developed for modules with a 4 × 4 m square plan, preserving the key geometric parameters and bar arrangements that demonstrated the most favourable structural performance in the earlier stage of the study. Both symmetric and asymmetric modules were examined, yielding a total of sixteen structural configurations. Parametric modelling was conducted in Dynamo, while structural analysis and design were performed using Autodesk Robot Structural Analysis Professional, applying load combinations in accordance with current design standards. The results indicate that the inclusion of atmospheric loads does not lead to substantial changes in the structural behaviour of the examined systems. For modules with non-planar mesh subdivisions, increasing the overall structural height results in higher stress levels, whereas the opposite tendency was observed for modules with planar mesh subdivisions. Moreover, the analysis shows that asymmetric modules achieve the best performance in configurations with non-planar mesh divisions, while symmetric modules are the most efficient when planar mesh divisions are used. The conducted analyses demonstrate that the structural behaviour of the examined models follows consistent trends under both permanent loads and combined permanent and atmospheric loads. The findings provide valuable insights for engineering practice and may inform further optimisation of lightweight modular steel structures based on HP geometry, both for single-module solutions and for multi-module configurations.

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STRUCTURE FROM MOTION PHOTOGRAMMETRY IN CONSTRUCTION: A LITERATURE BASED REVIEW OF USE CASES AND LIMITATIONS

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ABSTRACT

Structure from Motion photogrammetry has become an increasingly relevant method for digital data acquisition in construction and civil engineering. By using overlapping images, three-dimensional point clouds, digital terrain models, meshes and visual documentation can be generated without the need for expensive scanning equipment. This makes the method especially attractive for construction sites, earthwork measurement, facade inspection, infrastructure monitoring and digital asset management. However, the practical suitability of the method depends strongly on image quality, camera positions, surface texture, overlap, lighting conditions, georeferencing and the required level of accuracy. The aim of this review paper is to summarize the main construction related use cases of Structure from Motion photogrammetry and to discuss its most relevant limitations. The review is based on scientific publications, and case studies dealing with photogrammetric point clouds, construction progress monitoring, earthwork volume calculation, coastal and geotechnical monitoring, and digital modelling. The findings show that the method can provide fast, flexible and low-cost spatial data for many constructions related applications. At the same time, it is shown that the method should not be used without quality control, reference measurements or a clear understanding of its technical restrictions. It is concluded that Structure from Motion photogrammetry is a useful support tool in construction, but its application must be selected according to the task, site conditions and required accuracy.

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STUDY OF HIGH-VOLUME FLY ASH-SELF COMPACTING CONCRETE (HVFA-SCC) T-BEAM STRENGTHENING WITH CFRP USING FINITE ELEMENT METHOD

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ABSTRACT

Production of cement as a binding material for conventional concrete was produces carbon dioxide (CO2) that can pollute the environment. Mitigation for reducing CO2 emissions in the cement industry are substitutes cement with fly ash as concrete components. In addition, there are several factors that can affect the performance of reinforced concrete structures. Some of these factors include the age of the building, the effects of building fires, corrosion of steel reinforcement, and others. One step that can be taken is to reinforce concrete structures with Carbon Fiber Reinforced Polymer materials. This study presents a numerical study on High Volume Fly Ash Self Compacting Concrete (HVFA-SCC) strengthening using Carbon Fiber Reinforced Polymer (CFRP). Analysis was performed using finite element method with 3D-NLFEA package. Specimens are modelled as T Beam that receive flexural two-point loading at the 1/3 span of beam. There are 2 types of strengthening are used in this study: flexural strengthening and shear strengthening using CFRP. Modeling uses 4 T-beam test specimens with web width of 120 mm, flange width of 440 mm, flange plate thickness of 80 mm, and beam span of 3000 mm. The strengthening used are flexural strengthening with a CFRP width of 50 mm, flexural strengthening with a width of 100 mm, shear strengthening with a CFRP width of 250 mm and spacing of 300 mm, and shear strengthening with a CFRP width of 100 mm and spacing of 150 mm. This result show that flexural strengthening using CFRP increases beam capacity around 2.21% - 2.66%. Meanwhile, for shear strengthening show that CFRP sheet can increase shear capacity around 1.55% - 1.57%. It means that Carbon Fiber Reinforce Polymer are suitable for structural strengthening especially for High Volume Fly Ash Self Compacting Concrete material.

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SUBURBANIZATION PROCESSES IN SELECTED SETTLEMENTS OF THE MICROREGION HORNÁ ORAVA (MHO)

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ABSTRACT

Introduction: The paper addresses the process of suburbanization, which represents a key determinant of the spatial transformation of contemporary cities and their hinterlands. In the context of post-socialist urban development, these changes are particularly dynamic, often reshaping the traditional rural landscape into a hybrid semi-urban environment. It focuses on the suburban zone as an area directly adjoining the compact urban structure, where the most intense interactions between the core city and the surrounding rural environment take place, leading to a blurring of administrative and physical boundaries.

Objectives: The main objective of the paper is a theoretical and methodological discussion regarding the conceptualization of this process and the possibilities for its precise delimitation. It aims to bridge the gap between general urban theory and the specific realities of smaller regional centers.

Methods: The study approaches suburbanization as a complex phenomenon that simultaneously affects morphological, functional, and socio-demographic intra-urban structures. Methodologically, the research utilizes a combination of statistical data analysis, coupled with field surveys and GIS-based mapping. The theoretical assumptions are verified through an empirical analysis of residential suburbanization in selected localities of the Microregion Horná Orava (MHO), focusing on land-use changes and housing density.

Results: The empirical part identifies the specific extent and forms of suburbanization processes present within the selected localities. The analysis revealed a predominance of fragmented development, characterized by discontinuous residential expansion and a lack of adequate public infrastructure. Furthermore, the study identifies a distinct contrast between the original rural morphology and the new suburban typologies, leading to spatial conflicts and a gradual loss of the region's vernacular identity.

Conclusion: By verifying the theoretical premises in a specific regional context, the paper contributes to a better understanding of how suburbanization manifests in rural-urban transition zones and highlights the importance of a multidimensional approach to its study. Finally, the findings suggest that current spatial planning tools are often insufficient to manage this pressure, pointing to the urgent need for more integrated regional planning strategies.

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SUSTAINABLE URBAN MOBILITY IN TIRANA: PLANNING PRIORITIES, CHALLENGES, AND TRANSITION PATHWAYS

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ABSTRACT

Tirana has experienced rapid urban growth, risen motorization, and increased pressure on its transport system, producing congestion, accessibility constraints, and environmental impacts. This paper examines the main mobility challenges facing Tirana and evaluates the planning priorities proposed in the city's Sustainable Urban Mobility Plan as a framework for transition toward a more balanced and multimodal urban transport model. The study aims to identify the most relevant mobility strategies for Tirana and assess how they can reduce car dependence while improving transport efficiency, safety, accessibility, and urban liveability. Methodologically, the paper is based on a qualitative review of the Tirana Sustainable Urban Mobility Plan and its analytical and strategic components, with particular attention to network structure, modal split, public transport performance, pedestrian and cycling conditions, parking policy, and intelligent transport systems. As an illustrative neighbourhood-scale example, the paper uses Ish-Blloku, a central mixed-use district in Tirana, to examine how strategic mobility priorities shape pedestrian experience at the street and neighbourhood scale. The findings show that Tirana's mobility system remains constrained by growing private car use, limited road capacity, weak public transport integration, and persistent conflicts between motorized and non-motorized users. At the same time, the mobility plan outlines a clear policy direction through measures such as bus rapid transit, rail rehabilitation, a new multimodal terminal, integrated ticketing, improved bus priority, expanded pedestrian areas, cycling infrastructure, parking regulation, low-emission initiatives, and digital traffic management. The paper concludes that sustainable urban mobility in Tirana depends on a shift from traffic accommodation toward integrated, people-centred planning, where coordinated transport, public space, regulatory, and digital measures support long-term urban sustainability.

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THE EFECT OF WATER AND FROST ON CHANGES IN THE DISTRIBUTION OF AIR VOIDS IN THE STRUCTURE OF ASPHALT MIXTURES

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ABSTRACT

The air void content in asphalt mixtures is a parameter that significantly influences their properties. It determines factors such as resistance to permanent deformation, indirect tensile strength, compressive strength or sensitivity to water and frost. In laboratory tests, the hydrostatic method is most often used to determine the void content. However, the result of this test is limited to a percentage value only. It does not provide any information about the permeability or pore distribution in the samples. Quantitative and volumetric distribution, spatial arrangement and pore connections refer to the internal structure of the mixtures. Nowadays, thanks to modern technologies such as x-ray CT, we can examine the internal structures of materials without having to physically damage or destroy them. What is particularly helpful and important is that thanks to this method we can observe changes inside materials that occur as a result of external factors. The sample can be scanned multiple times and the scanning will not affect its condition. In asphalt mixtures, the external factor that undoubtedly influences the internal structure is the action of water and frost. This factor, over time, leads to deterioration of the mixtures. Moreover, in Poland's climate, it is impossible to eliminate. We can only minimize the effects of low temperatures. Therefore, it is very important to determine in more detail the changes in the internal structure of asphalt mixtures caused by the action of water and frost. Furthermore, we now use various technologies to produce asphalt mixtures. The goal is to reduce process temperatures, which is related to environmental protection. WMA asphalt mixtures are increasingly being used in road construction. Lowering process temperatures and using WMA additives can cause changes in the internal structure of the mixtures, despite using the same mineral mixture. Therefore, it is very important to verify these changes, as they may also have a further connection with water and frost resistance. In order to demonstrate the above-mentioned relationships, in this work the internal structure of AC 11S asphalt concrete was tested in HMA and WMA technologies. The internal structure of the samples was examined both before and after the frost resistance test according to two methods - described in WT-2 2014 and AASHTO T283. Internal structure analysis included zonation of the samples and changes along their height. The volumetric distribution of pores, their arrangement and their connectivity were analyzed. In each zone, changes due to freezing were demonstrated and compared between technologies. Differences were also demonstrated between the air void content estimated by computer and that obtained from hydrostatic testing.

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THE EFFECT OF WMA ADDITIVES AND AGEING ON THE PARAMTERES OF CAM MODEL FOR POLYMER MODYFIED ASPHALT

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ABSTRACT

Climate change necessitates the implementation of new technologies across all areas of human activity. These technologies should be energy-efficient and result in reduced greenhouse gas emissions. In road construction, the most energy-intensive process is the production of mineral-asphalt mixtures intended for the upper layers of road pavement structures. These are produced at temperatures ranging from 165°C to 180°C, depending on the type of asphalt used in the mineral-asphalt mixture. The production process is accompanied by the release of large quantities of greenhouse gases, including CO_2. In addition to the negative environmental impact of producing mineral-asphalt mixtures, the high temperature also accelerates the ageing of the asphalt. As a result of oxidation processes, the asphalt's viscoelastic properties deteriorate, causing it to stiffen and become brittle. The ageing process of the asphalt continues during the service life of the asphalt pavement. Mineral-asphalt mix is exposed to solar radiation, wind and water. As a result of the ageing process, the asphalt pavement may be subject to premature wear. In order to meet modern environmental and technological requirements, Warm Mix Asphalt (WMA) and Half Warm Mix Asphalt (HWMA) have been introduced into road construction practice. These are characterized by a lower temperature during production and incorporation into the pavement structure. They are produced at a lower temperature, typically between 35°C and 40°C, compared to traditional mineral-asphalt mixtures. Lowering the production temperature reduces greenhouse gas emissions and decreases the energy consumption of the production process. WMA and HWAM mixtures are produced using various suitable natural or chemical additives. The study utilized PMB 45/80-6 polymer-modified asphalt, to which WMA additives were applied in the form of synthetic wax at levels of 1.5%, 2.5% and 3.5% relative to the bitumen content, and a surfactant at levels of 0.2%, 0.4% and 0.6% by weight of the asphalt. The resulting binders were subjected to a long-term PAV (Pressure Aging Vessel) ageing process. The effect of WMA additives and the ageing process on the rheological properties of the binder was observed based on an analysis of changes in CMA (Christensen, Anderson and Marasteanu) model parameters, i.e. the cross-point frequency (fc), the rheological index (R) and the relative root mean square error (RRMSE). Based on the conducted research, conclusions were drawn regarding the significance of the influence of WMA additives in terms of long-term ageing on the rheological characteristics of PMB 45/80-6 polymer-modified asphalt, and recommendations were formulated regarding the quantities of additives to be used in the binder.

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THE EFECT OF WMA ADDITIVES AND THE AGING PRCESS ON THE CHEMICAL CHARAKTERISTICS OF ASPHALT

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ABSTRACT

Asphalt is an organic material that undergoes ageing during the production process and throughout the service life of mineral-asphalt mixtures in road pavements. A characteristic feature of the ageing process is the change in the viscoelastic properties of asphalt, caused mainly by oxidation processes. As a result of ageing, asphalt becomes stiff. The consequences of the phenomena occurring in asphalt are the formation of damage in the form of cracks and a loss of resistance to the effects of water and frost on the asphalt pavement, thereby reducing its service life. This article focuses on the use of two WMA additives in asphalt. A synthetic wax with a reduced carbon footprint and a tall oil amidepolyamines were used. The primary function of these additives is to act as ageing inhibitors and to improve the chemical properties of the asphalt. In the study, synthetic wax with a reduced carbon footprint was added to the asphalt at concentrations ranging from 1.0% to 2.5% by weight in 0.5% increments, and tall oil amidepolyamines at concentrations ranging from 0.0% to 0.6% by weight in 0.2% increments; a combination of these additives was also used. The modified binder produced was subjected to short-term (RTFOT) and long-term (RTFOT+PAV) ageing. The chemical composition of the binders was then analyzed using Fourier Infrared Spectroscopy (FTIR). The carbonyl, sulfoxide and aromatic indices of the modified binders were determined. The ageing indices for these binder properties were then determined. Analysis of the chemical composition of the binders before and after short-term and long-term ageing showed that the additives used inhibit the oxidation and aromatization reactions of the asphalt components. Consequently, the asphalt will age more slowly, ensuring greater service life for the asphalt pavement. Based on the analysis of chemical indices, the optimal contents of synthetic wax with a reduced carbon footprint and tall oil amidepolyamines in the asphalt were determined.

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THERMAL BEHAVIOUR OF BRICK FACADES IN HISTORIC INDUSTRIAL BUILDINGS: A CASE STUDY FROM VALLADOLID, SPAIN

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ABSTRACT

Currently, one of the requirements for new buildings is that they must be energy efficient and have near-zero energy consumption. This requirement has been extended to existing buildings, except for heritage buildings, where historical legacy and conservation take precedence. However, it is now necessary to understand the thermal behaviour of these buildings in order to find solutions that improve energy efficiency without altering their characteristics, as the solutions used in the energy refurbishment of other existing buildings cannot be applied to them. The envelopes of new buildings are lightweight and very well thermally insulated compared to older buildings, which have thick masonry walls, in this case brick, with high thermal inertia, but with much lower thermal transmittance values than new buildings. This characteristic means that they behave very differently thermally from new buildings, so alternative solutions must be sought that consider their thermal performance. This study compares the results of a theoretical study with the results of thermal flow tests carried out on site to determine the behaviour of a thick brick facade in an old building in relation to the thermal conditioning of the premises under study. The conclusion reached is that the actual performance is very different from the theoretical performance, as the heat flow resulting from the tests shows lower values than those in the theoretical study, which would imply a lower energy demand for conditioning the premises in both winter and summer. On the other hand, the performance in winter is very different from that in summer. In winter, it would be necessary to improve the thermal insulation of the facade, while in summer no improvement is necessary. It has also been determined that the calculated surface temperatures are different from those measured in the tests carried out, which would indicate that the possibility of surface condensation on the walls could be incorrectly verified, where humidity is one of the factors that can most affect their degradation.

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THERMAL CONDUCTIVITY COEFFICIENT OF FOAMED CONCRETE REINFORCED WITH POLYPROPYLENE FIBERS

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ABSTRACT

The aim of the study was to assess the effect of polypropylene fiber addition on the thermal properties of foamed concrete.

Foamed concrete has become increasingly common in recent years, primarily as a leveling, leveling-insulating, or insulating layer under industrial floors. In this case, the thermal properties of foamed concrete are very important. For this purpose, laboratory tests of the thermal conductivity coefficient of foamed concrete were conducted. Furthermore, given that tensile stresses will occur in the foamed concrete layer when used in an industrial floor structure, the flexural strength of such foamed concrete is also important. To improve the flexural strength of foamed concrete, polypropylene (PP) fibers were used as a component of the foamed concrete mix. PP fibers were used at approximately 0.2%, 0.4% and 0.6% by volume. Density and thermal conductivity coefficient tests were conducted for each sample. Density was determined analogously to traditional cement composites, while the thermal conductivity coefficient was determined using the IZOMET apparatus. It can be observed that with increasing polypropylene fiber content, the density of foamed concrete decreases. This relationship is linear. The thermal conductivity coefficient of foamed concrete samples with PP fibers was lower than that of the reference samples (without PP fibers) by approximately 10-20%.

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THE ROLE OF BLUE-GREEN INFRASTRUCTURE IN RESTORING THE QUALITY OF URBAN SPACES IN DEGRADED AREAS

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ABSTRACT

Contemporary cities are increasingly faced with the need to regenerate derelict and post-industrial areas, while also dealing with the effects of climate change, environmental degradation and rising expectations regarding the quality of life in urban spaces. Processes such as deindustrialisation, suburbanisation and spatial fragmentation have contributed to the emergence of vast urban landscapes characterised by a loss of function, environmental pollution, a lack of public spaces and a weakening of local social identity. In response to these challenges, blue-green infrastructure has become one of the key elements of contemporary spatial planning and sustainable urban regeneration.

The aim of this article is to analyse the role of blue-green infrastructure in the process of restoring and improving the quality of urban space in degraded areas. The study attempts to determine how blue-green infrastructure supports environmental, social and spatial regeneration processes, and how it contributes to building long-term resilience and the sustainable development of urban structures. The article is based on an interdisciplinary approach combining issues of urban planning, landscape architecture and environmental urban studies.

The article highlighted the diverse character of blue-green infrastructure and its ability to integrate ecological and social functions within the urban environment. The article analysed how blue-green infrastructure contributes to improving microclimatic conditions, increasing biodiversity, enhancing rainwater retention, mitigating the urban heat island effect, and restoring ecological connectivity within urban structures. Furthermore, the social dimension of blue-green infrastructure is discussed in terms of its functional and recreational aspects, as well as its role in supporting social integration and residents' sense of place.

The research methodology is based on a review of the literature on blue-green infrastructure and sustainable urban development, as well as a study of selected case studies, combined with a comparison analysis. The examples analysed demonstrate how ecological systems and public green spaces can act as catalysts for urban regeneration and spatial reintegration.

The article posits that blue-green infrastructure should not be viewed merely as an environmental or aesthetic addition to the city, but as a strategic and multifunctional planning tool. Its implementation contributes not only to improving the urban green structure, but also to rebuilding urban identity, enhancing the quality of space and strengthening the resilience of cities. The conclusions drawn from the research may contribute to the discussion on adaptive and regenerative approaches to contemporary spatial planning.

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THE SHIFT TOWARD MINERAL BUILDINGS MATERIALS IN MEDIEVAL EUROPEAN ARCHITECTURE: THE CASE OF TORUN

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ABSTRACT

This article investigates the medieval intensification of a long-term transformation in European building practice: the increasing use of mineral-based materials—fired brick, stone, lime mortar and plaster, ceramic roof coverings, and glass—within an urban architecture previously dominated by timber, wattle-and-daub, thatch, and other plant-derived components. Rather than interpreting this development as a linear substitution of organic materials, the study proposes the concept of selective material mineralization. This term denotes a redistribution of materials across building functions, whereby masonry increasingly defined foundations, party walls, façades, vaults, plot boundaries, and monumental structures, while timber continued to perform indispensable structural and technological roles in roof trusses, floors, internal partitions, scaffolding, and hybrid framed construction.

Toruń offers an exceptionally legible case study. Founded in the thirteenth century and integrated into the commercial and cultural networks of Hanseatic Europe, the city underwent a rapid consolidation of brick-built ecclesiastical, military, civic, mercantile, and residential architecture. The study argues that Toruń's medieval transformation did not eliminate organic construction but reorganized it within increasingly mineralized and durable building systems. The survival of the city's street pattern, brick architecture, plot boundaries, cellars, façades, decorative finishes, and timber roof structures—recognized through its inscription on the UNESCO World Heritage List in 1997—makes Toruń a rare material archive of this broader European shift. The case demonstrates that medieval urban mineralization should be understood as a layered, hybrid, and institutionally mediated process rather than a simple technological replacement.

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THE TRANSITION OF NON-FORMAL EDUCATIONAL SPACES IN ROMANIA: FROM CHILDREN'S PALACES TO MODERN EDUCATIONAL CENTERS

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ABSTRACT

Introduction. In Romania, non-formal education has a very important institutional tradition through the Children's Palaces, previously known as the Pioneers' Palaces, structures that took over, after 1989, part of the organization and infrastructure of the former institutions intended for extracurricular activities. Although these spaces have had a relevant role in the development of children's artistic, technical, cultural and sports skills, the current educational context requires a reassessment and reorganization of the way in which they function and respond to contemporary needs. Digitalization, new forms of interdisciplinary learning and the need for inclusive and stimulating environments require a transition from the traditional model, based on fixed workshops and rigid organization, to modern, flexible and interactive educational centers.

Objectives. This paper aims to analyze the transformation of non-formal educational spaces in Romania, following the evolution of the Children's Palaces and identifying the directions in which they can be reorganized in relation to contemporary non-formal educational centers. A central objective is to formulate spatial and functional organization principles capable of supporting a relevant educational framework for the present.

Methods. The research is based on a historical and typological analysis of the Children's Palaces in Romania and their transition after 1989, complemented by a case study of the National Children's Palace and a comparison with interactive non-formal educational centers developed in Europe and the U.S., such as the Experimentarium in Copenhagen or the Exploratorium in San Francisco. The comparative method follows the relationship between architecture, politics, social context, organization of activities, the degree of flexibility of the spaces and the types of educational experiences offered to users.

Results. The analysis aims to highlight the fact that the Romanian model retains the important advantages that were the basis of its concept, such as accessibility, public character and diversity of activities, but presents major limitations in terms of infrastructure, logistics, spatial adaptability and integration of current technologies. In contrast, modern educational centers favor exploration, direct participation, visibility of the learning process and the active relationship between the interior, exterior and community. The results indicate the need for a mixed model adapted to the social needs of Romania, which preserves the social and accessible dimension of the Children's Palaces, but introduces modern spaces, interdisciplinary laboratories, experimental areas, digital infrastructure and an architectural expression capable of stimulating curiosity and creativity.

Conclusions. The transition to modern educational centers does not imply abandoning the existing model, but rather reinterpreting it in relation to the current requirements of education. Modernizing non-formal spaces in Romania can contribute to creating more attractive, inclusive and efficient learning environments, capable of supporting the development of critical thinking, creativity and the skills needed for future generations.

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TOWARDS A REGIONAL CIRCULAR CONSTRUCTION FRAMEWORK: MATERIAL STOCKS, URBAN MINING AND GOVERNANCE IN THE RUHR AREA

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ABSTRACT

The construction sector is one of the most resource-intensive industries and is responsible for substantial material consumption, waste generation and greenhouse gas emissions. Circular construction is increasingly discussed as a strategy to reduce these impacts, yet implementation is often addressed at the level of individual buildings, materials or recycling processes. Less attention has been paid to the regional scale, although material availability, demolition activities, recycling infrastructure, transport distances and governance structures are highly spatially dependent.

Building on empirical findings from the Ruhr Area in Germany, this contribution develops a conceptual framework for regional circular construction. The framework links spatial material stock analysis, urban mining, circular economy strategies and regional planning instruments. The Ruhr Area represents a particularly relevant case due to its polycentric urban structure, post-industrial transformation and ageing building stock.

The empirical basis combines a systematic review of circular construction strategies, a spatially explicit building material stock analysis and a scenario-based material flow analysis. The results show that circular construction research is still predominantly focused on recycling, while higher-order strategies such as adaptive reuse, repair, refurbishment and repurposing remain underrepresented. At the same time, the building stock of the Ruhr Area contains approximately 1.16 billion tonnes of materials, mainly mineral construction materials. Scenario results indicate that circular strategies such as adaptive reuse, selective deconstruction and the use of recycled aggregates can significantly reduce primary raw material demand and associated carbon emissions.

Based on these findings, the proposed framework consists of five interrelated elements: mapping regional material stocks, matching secondary material supply and demand, prioritising higher-order R-strategies before recycling, governing intermunicipal cooperation and monitoring material flows through digital material cadastres. The paper argues that circular construction should be understood not only as a technical challenge but also as a regional planning and governance task. By translating material stock data into planning-relevant strategies, the framework provides a basis for developing regional circular construction systems in polycentric urban regions.

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TRADITIONAL ARCHITECTURE OF SOUTHERN BOSNIA AND HERZEGOVINA AND INFLUENCES ON MODERNISM

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ABSTRACT

Studying the traditional architecture of BiH as one of the Mediterranean countries of Europe, we discover a large number of basic principles of local vernacular architecture that correspond to modernist principles, applicable with entirely recent requirements for bioclimatic construction. The traditionally recognized playful design of white cubes, their geometric clarity and simplicity with the use of locally readily available natural materials will mark many successful modern works. The relation to the place, respect for the natural environment, adaptation to the terrain configuration, and climate conditions are timeless values taught by the traditional Bosnian house. The integration of the external, open, semi-open, and internal, closed space into a compact conceptual-content whole are proclaimed ideals of modern architecture, characteristic of the traditional house of BiH, especially in its warm south. The orientation and placement of the house towards the most beautiful vistas, volumetric extrusion towards greenery, and integration of greenery into the house space, green gardens, and courtyards, as well as a special relation towards water through its omnipresence, are features of high residential culture. In today's world, the humanistic principles in architecture, seldom mentioned anymore, are reflected in establishing an intense relationship between man and nature, family connection, based on real needs, utilitarian, social, but also aesthetic. The objects are never oversized, regardless of the power and possibilities of the owner, they do not dominate, but blend into both the natural and built environment. Flexibility in the use of residential space is yet another high quality achieved in the vernacular architecture of BiH, spaces are not burdened with heavy furniture, everything is built-in or movable, which is also a principle in many of the most successful accomplishments of modern architecture.

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TRAIN SET SELECTION AND CAPACITY PLANNING IN REGIONAL PASSENGER RAIL TRANSPORT

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ABSTRACT

Passenger railway transport constitutes a key component of sustainable regional mobility and public transport provision. Growing demands for the efficient use of public resources, service quality, and operational efficiency increase the importance of appropriate railway vehicle capacity planning. In practice, however, discrepancies frequently arise between offered transport capacity and actual passenger demand across different periods of operation, leading to inefficient resource utilization and increased operating costs.

This paper addresses the problem of train set selection in regional passenger railway transport with respect to required transport capacity and timetable design. The main objective is to propose a methodology for determining an appropriate vehicle type and capacity for a specific operational unit or railway line. Particular attention is given to demand variability, operational constraints, vehicle circulation, and economic efficiency.

The methodological framework is based on the analysis of operational data from regional railway services, passenger demand patterns, timetable characteristics, and rolling stock circulation principles. The proposed approach also evaluates the economic implications of operating different vehicle types, including operational and external costs. The methodology integrates operational, capacity, and economic criteria to support decision-making by transport authorities and regional public transport organizers.

The results indicate that appropriately designed vehicle capacity planning can improve rolling stock utilization, reduce operating costs, and contribute to a more efficient allocation of public resources. Furthermore, the findings confirm that a flexible approach to train set capacity allocation enables better responses to temporal demand fluctuations while maintaining service quality. The proposed methodology expands the analytical tools available for strategic planning, tender specification, and operational unit design in regional railway transport.

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TRAIN VELOCITY AS A FUNCTION OF VIBRATION COMFORT IN RESIDENTIAL BUILDINGS NEAR HIGH SPEED TRAIN IN POLAND

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ABSTRACT

For many years our Laboratory (Building Vibration Laboratory) which is a part of Faculty of Civil Engineering Cracow University of Technology, investigate some aspects of vibration caused by transport. One of the topics is vibration comfort of people inside residential buildings nearby line sources of vibration. Because of dynamic developing of high speed train lines in Europe, the problem of vibration comfort of people in buildings located near these lines becomes particularly important.

This publication addresses this issue as a function of the speed of individual train classes. Based on actual field measurements conducted by our unit, the publication includes the results and analyses of vibration measurements in accordance with Polish standards for assessing vibration comfort in rooms intended for permanent occupancy. Measurements for each location were conducted 24 hours a day.

Corresponding Author: Piotr Stecz

TRANSFORMING REGIONAL ENERGY SYSTEMS – AN INTEGRATIVE APPROACH TO OPTIMISED SITE PLANNING FOR HYDROGEN PRODUCTION

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ABSTRACT

Hydrogen is considered a key energy carrier for decarbonising and transforming energy-intensive industries, particularly in sectors that are difficult to electrify. As hydrogen demand is expected to increase in the near future, there is a need to establish an increasing number of suitable sites for electrolysis. However, the deployment of hydrogen in energy systems has so far been limited, as the planning and implementation of electrolysers face substantial challenges and uncertainties.

Economic feasibility remains dubious, particularly in comparison to natural gas, resulting in limited competitiveness and low industrial uptake. In addition, knowledge of the current and future spatial distribution of hydrogen demand and production capacities is still limited, especially from a medium- to long-term perspective. Furthermore, the suitability of electrolyser locations strongly depends on local conditions, including the availability of environmental resources, public supply infrastructure, and regional hydrogen demand.

To address these challenges, this study develops an integrated planning framework for identifying suitable electrolyser locations that are consistent with sustainable energy policy objectives and regional spatial planning practices. The proposed framework addresses the current lack of planning tools that integrate technical, economic, environmental, and spatial aspects into a single decision-support approach for optimising electrolyser siting within regional energy systems. Based entirely on open data, the tool represents a blueprint for infrastructure planners, which can be transferred to other regions easily.

A GIS-based Multi-Criteria Decision Analysis (MCDA) was conducted to identify suitable locations for electrolysers while considering environmental compatibility, economic efficiency, and security of supply. The evaluation criteria were weighted using the Analytic Hierarchy Process (AHP) based on an expert survey and applied in a case study. The study area forms part of the BMWK-funded HydroNet project, which aims to establish the Sauerland region in Germany as a hydrogen model region.

A total of 3,000 locations were identified as potentially suitable for electrolysis within the designated study area, meeting all relevant planning regulations and technical requirements. The results indicate that 19% of the study area, corresponding to 82.12 km², is suitable for electrolysis. The most influencing factors were connectivity to the planned hydrogen core network infrastructure and the local hydrogen demand. The proposed planning framework provides a transparent and transferable decision-support tool for strategic electrolyser siting, thereby supporting the efficient and sustainable transformation of regional energy systems.

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UNCOVERING TRENDS AND THEMATIC DOMAINS OF GREEN PROCUREMENT IN CONSTRUCTION: A GLOBAL BIBLIOMETRIC PERSPECTIVE

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ABSTRACT

Escalating environmental pressures, resource constraints, and increasing regulatory expectations are intensifying the need for more sustainable practices in the construction sector, a major contributor to global resource consumption, waste generation, and carbon emissions. In this context, green procurement has emerged as a critical mechanism shaping material selection, supply chain configurations, and markets for sustainable products and practices. By influencing supply and demand dynamics, it plays a central role in steering the sector toward more sustainable outcomes. Despite its recognized role in advancing sustainability transitions through approaches such as green public procurement (GPP), sustainable procurement (SP), and environmentally responsible sourcing, the literature remains fragmented across disciplines and thematic orientations, resulting in conceptual ambiguity and a limited understanding of how green procurement is structured and evolving within construction. To address this gap, this study employs a bibliometric approach to systematically examine the intellectual structure and development trajectory of green procurement research in construction. Drawing on the Web of Science (WoS) database, a total of 284 articles published between 2000 and 2026 were analyzed using VOSviewer through co-occurrence, clustering, and overlay analyses to identify thematic clusters, knowledge domains, and emerging research trends. The findings reveal five major thematic domains: (1) evaluation and compliance; (2) governance and decision processes; (3) circularity-oriented approaches; (4) implementation and practice; and (5) contextual and supply chain dynamics. These domains capture both regulatory and operational dimensions of green procurement and highlight the multidimensional nature of the field. The analysis further indicates significant conceptual overlap and interaction among clusters, suggesting that green procurement research evolves through interconnected and mutually reinforcing themes rather than isolated strands. Key concepts within these clusters reflect the principal theoretical and practical focal areas shaping the field. Overlay visualization further reveals the temporal evolution of the field, highlighting a growing shift toward circular procurement (CP) as a dominant and rapidly developing research direction that integrates circular economy (CE) principles into procurement strategies. By organizing and synthesizing dispersed knowledge, this study provides a structured and construction-specific understanding of green procurement research. The findings offer critical insights for policymakers, industry practitioners, and researchers by clarifying thematic priorities and supporting the development of more effective, resource efficient, and policy-informed procurement practices within construction management systems.

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UNIVERSAL ACCESS ANALYSIS OF WEELCHAIR RAMPS SURROUNDING THE UNIVERSIDAD DE SANTIAGO DE CHILE

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ABSTRACT

With the publication of the Law Nº 22.422 on 2010 establish the framework for universal access in Chile, which guaranties the equal opportunities and social inclusion of persons with disabilities. As a result of this law, in 2016 the General Ordinance of General Law on Urban Planning and Construction was modified to include the technical standards for design for universal accessibility for construction and urban planning. The objective of the modification was to facilitate and incorporate universal accessibility solutions in the design and selection of furniture and infrastructure elements in public spaces and housing intended for people with disabilities. This study focusses on the quality of the sidewalks and wheelchair ramps that surrounds directly the University of Santiago de Chile. The legal responsibility of the construction and maintenance of the sidewalks and road pavements corresponds to the Municipality and the Metropolitan Regional Government. Therefore, the responsibility of complies with the quality of the sidewalks and wheelchair ramps doesn't fall on the university but affects directly the quality of life of the students and faculties. As a result of the implementation of the universal access law, as a result of the modification of the General Ordinance an analysis of the wheelchair ramps that surround the campus was performed during 2019 and 2026 with the objective of determining the quality of the surrounding infrastructure. The analysis survey the existences of the wheelchair ramps, the type of ramp and if it complied with the technical standard. The initial survey in 2019 detected 49 sidewalks around the campus, with only 42 wheelchair ramps in existence, and only 6 of them complied with the model type but not with the required dimensions. Comparing with the new survey performed in February 2026, only 3 new wheelchair ramps where added, but did not respect the minimum dimensions standards. As a result, it is possible to conclude that the perimeter of the University doesn´t comply with the universal access established by the law, and no significant improvements has been performed by the corresponding authorities. This study can help the central university authorities, pressure the local Municipality to modify the existing infatuation and comply with the national standard with the resulting improvement of life quality for the community.

Corresponding Author: Christian Seal

URBAN REHABILITATION OF CULTURAL HERITAGE: FROM INTERNATIONAL CONVENTIONS TO NATIONAL PRINCIPALS

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ABSTRACT

The creation of the Recovery Programme for the Historic Villages from the 1990s in Portugal, identified 12 cases in the Central Region of the country. Since then, these villages, located in the poor and sparsely populated Interior of the country near the border with Spain, have been struggling to survive. The ongoing population decline toward the Atlantic and Mediterranean coasts, along with the aging of those who remain, is a reality that makes the implementation of urban rehabilitation policies and the attraction of investment increasingly difficult. In this sense, this research is organized into two fundamental main goals. The first corresponds to identify the general principles and concepts, coming from the international charters and recommendations concerning urban rehabilitation and the safeguarding of cultural heritage. The second goal is an analysis of urban rehabilitation and heritage policies in Portugal, including the Recovery Programme for Historic Villages, and its experience of several decades. It seeks to present an approach that encompasses the knowledge drawn from international recommendations on cultural heritage protection and urban rehabilitation through to national principals. The conclusions have revealed that international conventions are clearly establishing the rules and standards to the conservation and rehabilitation of historical and cultural heritage sites. Therefore, is essential first to identify the tangible and intangible values intended for preservation. Secondly, the decisions made during the intervention process, whether regarding the use of contemporary materials and techniques or the addition or removal of elements, must be carefully justified and respect these identified values. The discussed recommendations in this research emphasize that urban rehabilitation actions should be grounded in rigorous scientific evidence, involving specialists from diverse professional fields, in a multidisciplinary approach.

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URBAN REHABILITATION PROJECTS: THE HISTORIC VILLAGE OF IDANHA-A-VELHA

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ABSTRACT

In the 1990s, the creation of the Program for the Recovery of the Historical Villages of Portugal identified 12 cases in the central region. The object of study of this paper is one of them: the historic ensemble of Idanha-a-Velha, classified as a national monument, which constitutes an example of considerable scientific interest. However, the process of safeguarding and enhancing the heritage proved to be complex, given depopulation and socioeconomic stagnation, reflected in the degradation of the built fabric. It will be focused on the study of Idanha-a-Velha as an example of the cultural heritage. Its significance reflects values of memory, antiquity, authenticity, originality, rarity, uniqueness, and exemplarity. Atelier 15's projects are considered, in addition to representing an example of good practice, to constitute a decisive milestone in the preservation and safeguarding of the heritage of its urban fabric. This research will be focused on a critical analysis of the projects by Atelier 15 to this historical village. They include proposals to the most interested monuments, such as the cathedral or the city walls, as well related with public spaces, such as the surroundings of the cathedral. It can be concluded that the intervention undertaken by Atelier 15 in this village is a positive example of heritage preservation. Although some aspects, such as the reconstruction of the North Gate, do not fully comply with international recommendations, most actions align with recognized standards and charters. Looking ahead, consistent maintenance will be crucial to prevent minor issues from evolving into major works. Future efforts should prioritize previously other architectural landmarks, while tourism investment may stimulate economic development, safeguarding the village's traditional life and cultural identity must remain central. The rehabilitation of the Historical Villages will continue to demand multidisciplinary involvement and collaboration between public and private stakeholders.

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URBAN ROAD NETWORK RESILIENCE UNDER PLUVIAL FLOODING: A FUNCTIONAL DISRUPTION PERSPECTIVE

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ABSTRACT

Urban pluvial flooding poses critical challenges to the operational continuity of transport infrastructure, yet city-scale assessments of flood-induced road disruption remain limited. In resilience assessment, exposure analysis represents an initial step, as it identifies the transport network components potentially affected by flood stressors. This study develops a GIS-based framework to evaluate Flood-Induced Functional Disruption Potential (FIFDP) across the urban road network of Antwerp, Ghent, and Leuven, in Belgium, under a 10-year return period (T10) pluvial flood scenario. FIFDP is defined as the potential for operational impairment resulting from the combined effect of flood intensity and road segment criticality. OpenStreetMap road data were integrated with a centimeter resolution pluvial flood depth raster. Flood depths were reclassified into three hazard categories and spatially intersected with buffered road segments, with buffers assumed to approximate effective carriageway area. Within this framework, road criticality is represented by the OpenStreetMap road hierarchy, in which primary and secondary roads are treated as key segments because of their higher functional importance for urban connectivity. A classification matrix combining hazard intensity and road hierarchy was then used to assign each segment to a low, medium, or high disruption-potential class. Two indicators were derived: Moderate-to-High Disruption Share (MHDS), defined as the percentage of total road surface area in the combined medium- and high-disruption classes, and High Disruption Share (HDS), defined as the percentage in the high-disruption class alone. The results reveal distinct intercity patterns. Leuven records the highest MHDS (26.72%), indicating broader network-wide sensitivity, while Ghent shows the highest HDS (0.86%), indicating a greater concentration of severe impacts on key road segments exposed to the highest hazard level. Antwerp records the lowest values for both MHDS (11.21%) and HDS (0.02%), indicating lower sensitivity within the adopted framework. These intercity differences reflect variations in the spatial distribution of pluvial flood depths and road-network structure, particularly the extent to which higher-order roads intersect medium- and high-hazard zones. The proposed framework provides a transparent and transferable method for rapid screening of road-network sensitivity to pluvial flooding and supports evidence-based resilience planning, including the prioritization of adaptation measures, drainage improvements, and emergency response strategies that can strengthen long-term urban transport resilience.

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URBAN THEORIES FOR SMART CITIES: AI-DRIVEN PREDICTIVE MODELING FOR SUSTAINABLE INFRASTRUCTURE DESIGN

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ABSTRACT

The aim of the study is to investigate the effect of artificial intelligence and urban theory in design and urban planning for smart cities. The objective of the study is to investigate the role of Artificial Intelligence (AI) in reshaping infrastructure design and urban planning through real-time data and analytics to automate urban planning process. This study synthesizes the key research and reports that highlight real-time analytics and predictive maintenance across transportation, energy and environmental sectors. To support sustainable urban development with the help of AI-enabled frameworks such as digital twins and geospatial tools. Studies credit artificial intelligence (AI) for changing the infrastructure design and urban planning in the context of data-driven, predictive, and adaptive management of urban systems. Ten studies and six reports explicitly highlight the role of Machine learning techniques primarily in conceptual analyses. Additionally, there are seven similar studies which emphasize the artificial intelligence (AI)'s integration with Internet-of-Things (IoT) technologies. Many papers highlight AI for employing real-time data and analytics, which implies to enhance the decision making and automating the complex nature of the urban planning process. Progressions of infrastructure in sectors like transport, energy and environmental systems are also contributed through AI predictive maintenance and dynamic system control. Moreover, by combining integrated frameworks like digital twins, geospatial tools and inter-disciplinary methodologies, AI can play a key role in supporting sustainable urban development. The advantages also include simplified traffic flow, proactive resource management and optimized energy use. However, various studies reflect concern findings from studies on data quality, privacy and ethical challenges, privacy and the requirement for regulation.

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VERIFICATION FEM ANALYSES IN SCIA AND ANSYS SOFTWARE OF SLENDER STEEL L-SHAPED FRAME – 2D SHELL VS. 1D BEAM MODEL WITH WARPING DOF

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ABSTRACT

Accurate numerical modelling of slender steel members subjected to torsion requires consideration of cross-sectional warping effects. Conventional six-degree-of-freedom (DoF) beam formulations are often insufficient in such cases, leading to inaccurate prediction of stresses, rotations, and internal forces. Therefore, advanced 1D beam elements incorporating the additional warping degree of freedom, commonly referred to as the 7th DoF and based on Vlasov's theory of torsion, are increasingly applied in engineering practice. The present contribution focuses on the numerical verification and mutual comparison of finite element (FEM) analyses of a slender steel L-shaped frame using different modelling approaches and software tools, including a basic sensitivity study of the numerical response to the adopted modelling strategy.

The study investigates a planar L-shaped frame composed of an I-section made of structural steel S235. Three numerical modelling strategies are considered: (i) a 1D beam model with warping DoF implemented in ANSYS using the BEAM188 element, (ii) an equivalent 1D beam model with warping implemented in SCIA Engineer (available since version 26), and (iii) a detailed two-dimensional (2D) shell model created in SCIA Engineer. The 2D shell model serves as a reference solution and employs integration members to consistently evaluate and integrate warping deformation, rotation about the local longitudinal axis, and the associated bimoment along the entire length of the frame members (except within the joint area). These integrated results are subsequently compared with the responses obtained from the 1D beam models.

ANSYS is adopted as a benchmark solver due to its long-term acceptance as a robust and reliable research-grade FEM tool. SCIA Engineer is assessed against this benchmark, motivated by its user-friendly graphical interface and efficient implementation of advanced beam features, including straightforward definition of warping behaviour and convenient post-processing that allows direct comparison between shell-based and beam-based results (using so-called integration member). The study evaluates whether this practical and accessible modelling approach provides results consistent with those obtained from ANSYS.

Additionally, three joint configurations at the L-frame corner are analysed, each influencing the transmission of warping in a different manner: a diagonal stiffener, a box stiffener, and a combined box-and-diagonal stiffener. For the 1D beam models with warping, appropriate constraint equations are introduced at the joint to represent the respective warping transmission mechanisms. The comparative results demonstrate the influence of joint detailing on warping behaviour and provide insight into the reliability and applicability of advanced 1D beam models for slender steel frames in engineering practice.

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VERIFICATION OF THE LOAD-BEARING CAPACITY OF CONFINED MASONRY WALLS USING A SHELL MODEL

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ABSTRACT

Confined masonry structures are used to enhance the resistance of buildings to seismic and paraseismic actions. Due to the construction technology, the internal forces in masonry panels are lower than in the case of infill walls within reinforced concrete frames, while the interaction with reinforced concrete elements increases the load-bearing capacity of the entire structural system more effectively than in reinforced masonry solutions. This paper presents a procedure for verifying ULS conditions of confined masonry walls based on a plate (shear wall) model, fully consistent with the draft Eurocode 6 (prEN 1996-1-1:2019). The main objective of the study is to address the design aspects of confined masonry walls subjected to combined shear and compression in accordance with prEN 1996-1-1:2019. Current recommendations concerning ULS shear verification of both masonry and reinforced concrete elements are discussed. In addition, equations describing ULS bending conditions are presented. In view of the limited number of publications addressing the design of confined masonry structures, the paper fills an important gap in the existing literature. The proposed method may be applied in engineering practice for the verification of ULS conditions of confined masonry walls.

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VERIFICATION OF THE LOAD-BEARING CAPACITY OF CONFINED MASONRY WALLS USING THE STRUT-AND-TIE (S–T) MODEL

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ABSTRACT

Confined masonry constitutes an alternative to reinforced masonry structures and, to some extent, resembles masonry infill within reinforced concrete frames. The differences arise from the composite interaction between the masonry panel and the confining elements, which significantly affects the structural behavior. Confined masonry exhibits greater ductility than reinforced masonry, while its load-bearing capacity is generally lower than that of masonry infill within frames. The plastic behavior of the masonry and its interaction with the reinforced concrete cores allow the resistance to be determined using limit analysis methods, including Strut-and-Tie (S–T) models and limit plasticity methods (LPM). This paper presents an adaptation of the S–T method used in American standards such as ASCE/SEI 41-06, ASCE/SEI 41-13, FEMA 274, FEMA 306, and MSJC (2010), which are also applied to masonry infill walls. Certain modifications were introduced to align the method with the provisions of Eurocode 6 (prEN 1996-1-1:2019) and Eurocode 2 (EN 1992-1-1). At the ultimate limit state (ULS), two static schemes are proposed for determining the shear resistance of the wall. Scheme 1 corresponds to failure due to diagonal strut crushing in shear, while Scheme 2 represents truss failure resulting from yielding of the tensioned vertical reinforced concrete core. In view of the lack of publications addressing the design of confined masonry walls using the S–T method, the paper fills a clearly identifiable gap in this field. The proposed approach may be applied in engineering practice for ULS verification of confined walls, with the limitation to a single panel configuration—one diagonal strut and two confining elements.

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VISUAL AND COMPOSITIONAL ANALYSIS OF THE DEVELOPMENT OF MUNICIPALITIES WITHIN THE MICROREGION HORNÁ ORAVA (MHO)

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ABSTRACT

Introduction: The Microregion Horná Orava (MHO) underwent an intensive process of urbanization in the second half of the 20th century, driven by rapid industrialization and subsequent post-socialist suburban tendencies. This dynamic shift fundamentally affected the visual character of settlements, their urban structure, and compositional relationships within the landscape, often disrupting the traditional rural fabric.

Objectives: The paper focuses on the visual and compositional analysis of the development of municipalities within the MHO microregion. The primary aim is to identify the main forms of spatial transformation and their consequences for the identity of rural settlements, specifically examining the tension between traditional vernacular morphology and contemporary building pressures.

Methods: The analysis is conducted across multiple spatial scales—from the microregional level, through the settlement and zone level. Methodologically, the research is based on a multicriteria evaluation of urban composition, combining qualitative and quantitative approaches and utilizing a comparative analysis of historical cartographic materials against current field survey data. Particular attention is devoted to the relationship between settlements and the landscape relief, as well as the settlement panorama.

Results: The research highlights the degree of alignment or discrepancy between the declared objectives of spatial planning documents that promote regulated development and the actual implementation in the territory. The findings indicate that despite planning efforts, there is often a divergence between theoretical regulation and reality. This is specifically manifested in the placement of new construction in visually sensitive exposure zones, leading to a visible loss of architectural cohesion.

Conclusion: The smissing conception and discrepancy often results in fragmented and chaotic patterns of development that degrade the visual quality of the countryside. These spatial transformations have significant implications for the identity of rural settlements, necessitating a re-evaluation of how spatial planning tools are applied to preserve the landscape's compositional integrity and ensure the long-term sustainability of the region's cultural heritage.

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