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CAUSummit 2026

11th World Summit from EARTH to URBAN - for Safe & Sustainable Cities

CIVIL ENGINEERING - ARCHITECTURE - URBAN PLANNING CONGRESS

Eco-friendly Congress - CAUSummit

ABSTRACT BOOK

31 August-4 September, 2026- Sofia (Bulgaria)

UNIVERSITY OF ARCHITECTURE CIVIL ENGINEERING AND GEODESY

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"The Meeting Point for Civil Engineers, Architects, City & Urban Planners"

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Preface

This Abstract Collection Book contains the abstracts of the oral and poster presentations accepted for the **11th World Summit: Civil Engineering – Architecture – Urban Planning Congress (CAUSummit 2026)**, held in Sofia, Bulgaria, from **31 August to 4 September 2026**.

CAUSummit was established to promote multidisciplinary collaboration among researchers, academics, professionals, and practitioners working in the fields of Civil Engineering, Architecture, and Urban Planning. Its primary mission is to encourage scientific exchange, strengthen international cooperation, and foster interdisciplinary research addressing the challenges of creating safe, resilient, and sustainable built environments.

The main theme of **CAUSummit 2026**, *"From EARTH to URBAN – for Safe & Sustainable Cities,"* reflects the entire process of creating sustainable communities—from understanding the natural environment and geological conditions to planning, design, construction, environmental management, and urban development. Throughout the congress, participants explored innovative approaches, shared recent scientific advances, and discussed practical solutions for developing cities that are safer, more resilient, and environmentally responsible for future generations.

The **11th World Summit: Civil Engineering – Architecture – Urban Planning Congress (CAUSummit 2026)** provided an international platform for presenting and discussing the latest research findings, emerging technologies, and innovative applications across a broad range of disciplines related to Civil Engineering, Architecture, and Urban Planning. The congress also encouraged collaboration among researchers from different countries and institutions by providing opportunities to exchange knowledge, establish new partnerships, and develop future research initiatives. Furthermore, CAUSummit continued its commitment to supporting early-career researchers by offering them an international forum in which to present their work and engage in scientific discussions with experienced scholars and professionals.

CAUSummit 2026 was organized in Sofia, Bulgaria, under the auspices of the **University of Architecture, Civil Engineering and Geodesy (UACEG)**. I would like to express my sincere appreciation to **Assoc. Prof. Dr. Arch. Gichka Kutova Kamenova**, Rector of UACEG and Honorary President of CAUSummit 2026, for her generous support, valuable cooperation, and warm hospitality throughout the organization of the congress.

I also extend my heartfelt thanks to all participants, keynote speakers, invited speakers, members of the Scientific Committee, reviewers, session chairs, and organizing committee members whose dedication and contributions ensured the success of CAUSummit 2026. My sincere appreciation also goes to all authors from around the world for sharing their valuable research and for contributing to the scientific quality of this congress.

I hope that both the scientific discussions during the congress and the abstracts presented in this volume will inspire future research, strengthen international collaboration, and contribute to the advancement of knowledge in Civil Engineering, Architecture, and Urban Planning.

Finally, I would like to thank all participants for being part of CAUSummit 2026. I sincerely hope you enjoyed both the scientific programme and your stay in Sofia, Bulgaria. I look forward to welcoming you again to the **12th World Summit: Civil Engineering – Architecture – Urban Planning Congress (CAUSummit 2027)**, which will be held from **6 to 10 September 2027**.

Prof.Dr. Isik YILMAZ
President of CAUSummit

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Land Subsidence and Its Impact on Transportation Infrastructure

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ABSTRACT

In recent years, some countries have experienced significant land subsidence. The primary causes of land subsidence range from excessive extraction of underground fluid resources, such as water, to the oxidation of peat soil layers. The impact of land subsidence on transportation infrastructure in these regions has been substantial, affecting railways, highways, and roads. International organizations and infrastructure development agencies carry significant responsibility in addressing these challenges. Therefore, this paper examines the factors contributing to land subsidence and presents case studies highlighting the effects of subsidence on transportation infrastructure, including railways, roads, highways, and expressways, in affected countries.

Key-words: Land subsidence, infrastructure, railway, highway, freeway

Possible Impact of Cycling Duration on Slake Durability Index Test

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ABSTRACT

The slake durability index (SDI) test is generally practical, easy and a standardized test which is mostly used to measure degradability of soft and weak rocks such as mudstone and gypsum. The SDI test is also regularly used to find out interaction of carbonate rocks with water by means of their durability. The SDI test simulates a process of repeatedly tumbling rock lumps which are approximately and equidimensional 10 pieces of about 40 g to 60 g each in water for 10 minutes at 20 revolutions per minute (20 rpm). The SDI is commonly calculated at the second cycles, Id2, but can also be calculated for each cycle. Even though the SDI test standards suggest that rock lumps should be cycled for 10 minutes, but this process can be considered somehow time-dependent slake durability and the impact of cycling duration needs to be explored systematically. Hence, this study is intended to investigate and quantify the impact of cycling duration on the SDI by using two different rock types: evaporite and carbonate from Al Ain, Abu Dhabi, United Arab Emirates. A total of 20 rock block samples were collected from three carbonate Formations (five blocks from each Formation); Dammam, Simsima, and Asmari, and from the Lower Fars Formation (only five blocks) evaporites outcropped in Al Ain region. Five sets of slake durability test samples from each carbonate and evaporite rock blocks were prepared according to ASTM (American Society Testing Materials) Standard and tested for 5, 10, 15, 20 and 25 minutes per cycle to perceive a possible impact of cycling duration on the SDI. After 4 cycles, the study revealed that carbonates from Dammam and Simsima Formations are invariably in an extremely high-durability range according to the SDI classification (all values $\geq$ 97.45 %), while carbonate from Asmari Formation also remains in a very high-durability class despite somewhat declines. The evaporites show a strong sensitivity to cycling duration, which is consistent with rapid dissolution and anhydrite/gypsum hydration, which progressively weakens the rock fabric (ranges 91.44% - 36.54%). Overall, the study demonstrates that while cycling duration is a secondary control for dense carbonates, but it strongly amplifies degradation in evaporites. Accounting for this time dependence improves the reliability of slake durability–based assessments in mixed carbonate–evaporite terrains such as Al Ain. Furthermore, it may also help the practitioners to discover a possible impact of cycling duration on the SDI and may save times, induce safe concerns of structures and reduce the expenses.

Key-words: Slake durability index, Carbonate, evaporite, durability, cycling duration

Surface Water Quality and Environmental Management in the Cheffia and Mexa Dams- Algeria

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ABSTRACT

The assessment of physicochemical and organic parameters of surface waters from the Cheffia and Mexa dams in 2020 provided valuable insights into their suitability for future use. Hydrochemical analysis indicates that water mineralization is mainly controlled by the major ions Ca^{2+}, Na^{+}, SO_4^{2-}, HCO_3^{-}, and Cl^{-}, with concentrations remaining within the guideline limits established by the World Health Organization (WHO). The Organic Pollution Index (OPI) reflects low to moderate levels of organic contamination, while the Raw Water Quality Index (WQI) classifies the waters of both reservoirs as acceptable for use. Despite the relative abundance of surface water resources, their exploitation remains limited, whereas groundwater abstraction continues to intensify. Water demand, estimated at 251.25 Hm^3 in 2015, is expected to increase to between 533.2 and 655.6 Hm^3 according to AEA projections. In response to these growing pressures, local authorities have initiated development programs aimed at enhancing both conventional and non-conventional water resources, notably through dam construction and inter-basin water transfer schemes. A systemic analysis of the El Tarf water system reveals that current constraints are not solely related to resource availability but are also strongly influenced by management inefficiencies, including low distribution network efficiency (approximately 50%) and insufficient mobilization of surface water resources. This study emphasizes the importance of water quality assessment as a fundamental component of sustainable water resources management. The findings highlight the urgent need for integrated water demand management strategies that promote the optimal use of existing resources and the rationalization of water-related investments.

Key-words: The organic pollution index; water quality index; mobilization of surface water resources; El Tarf region

Climate Change and Soil Degradation in Northern Algeria: Challenges and Pathways for Resilience

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ABSTRACT

Northern Algeria (Tell, Hauts-Plateaux, and northern steppe areas) is home to more than 90% of the population and most of the country's agricultural land, but it faces increasing vulnerability due to climate change and soil degradation. Over the past few decades, the average temperature has risen by around +1 to +1.5°C, while rainfall has decreased by 10 to 25% at several stations in the high plateaus. This change has been accompanied by increased rainfall variability, characterized by more frequent droughts and episodes of intense rainfall that promote runoff. Soil degradation is a major issue in this region. Water erosion affects approximately 3 to 5 million hectares in the north, particularly in the Tellian massifs (Kabylie, Aurès, Ouarsenis), with losses exceeding 20 to 30 t/ha/year on cultivated slopes without vegetation cover. Nationwide, more than 12 million hectares are affected by various forms of degradation. In the Hauts-Plateaux, the steppe—a strategic ecological transition zone—has experienced a significant decline in vegetation cover, with degradation estimated at more than 50% in some pastoral areas. In addition, salinization affects about 10 to 15% of irrigated land, reducing agricultural yields by 20 to 40% depending on the sensitivity of the crops. Semi-arid cereal soils often have organic matter contents of less than 1.5%, limiting their water retention capacity and resilience to drought. These dynamics have a direct impact on food security. National cereal production, which is heavily dependent on rainfall in the north, can vary from more than 60 million quintals in favorable years to less than 30 million in periods of drought, illustrating interannual variability that can exceed 50%. In response to these challenges, several adaptation and resilience strategies are emerging. Conservation agriculture (direct seeding, permanent ground cover, legume rotations) reduces erosion by 30 to 60% and improves water infiltration. Rainwater harvesting techniques (benches, stone barriers, micro-basins) promote local recharge and restoration of vegetation cover. Reforestation and watershed protection programs, with more than 800,000 hectares reforested since 2000, contribute to soil stabilization and the fight against dam siltation. Finally, the use of remote sensing (NDVI, GIS) improves the monitoring of degradation and the identification of priority areas for intervention. In conclusion, in northern Algeria, climate change acts as a multiplier of pressures on soils already weakened by inappropriate practices and strong demographic pressure. Strengthening resilience relies on an integrated approach combining sustainable soil management, water optimization, restoration of steppe ecosystems, and territorial governance adapted to semi-arid Mediterranean conditions.

Key-words: Climate change; soil degradation; semi-arid regions; Northern Algeria; land resilience

Climate Change, Soil Degradation, and Baseflow Dynamics in Semi-arid Basins of Northern Algeria

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ABSTRACT

The semi-arid watersheds of northern Algeria have hydrological regimes characterized by high interannual and seasonal variability, where wadi flows are dominated by rapid floods while baseflows maintain flow rates during dry periods. Baseflow represents the delayed contribution of groundwater to river flow and is an essential indicator of the hydrological functioning of watersheds and the availability of water resources. In the semi-arid Mediterranean context, climate change and soil degradation are profoundly altering hydrological processes. Several studies have shown that rainfall variability, rising temperatures, and recurring droughts are affecting aquifer recharge and water resource availability in northern Algeria's basins. In addition, soil erosion processes, reduced vegetation cover, and the formation of surface crusts reduce infiltration and promote rapid runoff, thereby limiting the contribution of groundwater to surface runoff. In order to assess these hydrological dynamics, this study analyzes the spatial and temporal variability of the Base Flow Index (BFI) in northern Algeria. The study area covers approximately 227,740 km² and includes 15 watersheds representative of the main hydrological units in the region. The BFI, defined as the ratio of base flow volume to total flow, is a widely used indicator for characterizing low flows and the contribution of groundwater to river flows. The calculations were performed using BFI version 4.1 software, which allows the hydrograph to be separated into rapid flow and base flow. This method also makes it possible to identify anthropogenic hydrological disturbances independently of climatic influences and to improve the regionalization of hydrological characteristics in ungauged basins. The results show significant spatial variability in BFI trends across northern Algeria. A significant downward trend was observed at the Oued El Abtal station (west), on an annual basis and during the November–March period, indicating a gradual decrease in the contribution of groundwater to runoff. In contrast, the Lakhdaria (center) and Ain El Assel (east) stations show no significant trend. Turgo North (northwest) and Chemorah (east) show a reversal in trend, characterized by an initial increase followed by a recent decrease. Seasonal analysis reveals that the most marked decreases occur in winter and spring, seasons that account for more than 60% of annual precipitation and largely control aquifer recharge and interannual variability in the BFI. These results also confirm that BFI values strongly reflect the geological and hydrogeological characteristics of watersheds, with low values associated with low-permeability formations, while high values correspond to more permeable aquifer formations that promote recharge and groundwater contribution to runoff. In the context of climate change, several studies also indicate that future flows in some basins in northern Algeria could decrease during the 21st century, which would increase pressure on water resources. In this context, sustainable watershed management requires the integration of strategies aimed at strengthening hydrological

resilience, in particular through soil conservation, integrated groundwater management, and artificial aquifer recharge, for example via infiltration basins or recharge dams. Thus, analysis of the base flow index is a useful tool for better understanding the hydrological response of semi-arid basins in northern Algeria to climate change and anthropogenic pressures, and for guiding strategies for adaptation and sustainable water resource management.

Key-words: Base Flow Index (BFI); climate change; groundwater recharge; Mediterranean hydrology, Northern Algeria

Forecasting Short-term Rainfall Using GNSS-PWV and Machine Learning Methods

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ABSTRACT

Accurate short-term rainfall forecasting is critical for hydrological risk management, early warning systems, and climate resilience. In this study, we explore the potential of Global Navigation Satellite System-derived Precipitable Water Vapor (GNSS-PWV) as a predictive variable for short-term rainfall forecasting using machine learning techniques. We use long-term GNSS-PWV time series from selected stations provided by the Nevada Geodetic Laboratory (NGL), combined with satellite-based rainfall data from the GPM IMERG product. Multiple machine learning models were tested, including multilayer perceptrons (MLP), random forest regressors, and long short-term memory (LSTM) neural networks. The models were trained to predict rainfall intensity at lead times of up to 24 hours, using recent PWV sequences as input features. Results show that GNSS-PWV carries significant predictive power, especially in humid and convective regions, with LSTM models achieving the best performance in capturing temporal patterns and non-linear dependencies. This study demonstrates the viability of GNSS-PWV as a meteorological proxy for short-term rainfall forecasting and highlights the value of integrating geodetic data with AI methods for atmospheric applications.

Key-words: GNSS, PWV, machine learning, rainfall, climate change

Comparative Analysis of Traditional Surveying, Single-Beam Sonar, and LiDAR for Underwater Construction Verification: A Case Study from the Everglades Agricultural Area

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ABSTRACT

Bathymetric surveying is critical to construction verification, payment determination, and hydraulic performance on U.S. Army Corps of Engineers (USACE) water-resource projects. This paper presents a comparative analysis of traditional rod-and-tape methods, single-beam echo sounding (SBES), and bathymetric LiDAR within two Everglades Agricultural Area (EAA) conveyance canals: the C-623 Inflow/Outflow Canal and the C-636 Seepage Canal. Guided by USACE EM 1110-2-1003 and related federal standards, the study combines literature review with a case study using real project data, including traditional cross-section surveys, SBES surveys, machine-control digital terrain models (DTMs) from GPS-equipped excavators, and geotechnical investigations documenting fluid-mud conditions. Results show that traditional rod-and-tape measurements and machine-control DTMs consistently reached the consolidated limestone bottom and matched design grade, while SBES depths were systematically .5–4 ft shallower in reaches with cohesive sediment accumulation. Geotechnical and USACE technical reviews confirmed the presence of a 1–2 ft fluid-mud layer with low density, negligible shear strength, and strong acoustic reflectivity. Thus, causing SBES returns from the top of the soft layer rather than the true bottom, a failure mode explicitly described in EM 1110-2-1003 Appendix P and corroborated by recent ERDC testing. LiDAR, although effective in clear shallow water, was deemed unsuitable for the turbid, organic-rich EAA canals. The study concludes that SBES efficiency advantages are negated in fluid-mud environments and recommends hybrid verification workflows that combine sonar, manual probing, sediment characterization, and machine-control data for future USACE projects in cohesive or low-clarity conditions.

Key-words: Bathymetric surveying; single-beam sonar; underwater construction verification

Synergetic Monitoring of Collapses above Chelopech Mine: Integrating DInSAR and Geodetic Techniques

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ABSTRACT

This study presents a monitoring strategy for detecting surface deformations above the Chelopech underground mine, Bulgaria. The research evaluates the effectiveness of complementing traditional high-precision geodetic methods—including Total Station surveys and Terrestrial Laser Scanning (LiDAR)—with satellite-based Synthetic Aperture Radar (SAR) data. The analysis covers two distinct periods (September–December 2024 and 2025) to assess ground stability in potential collapse zones. Radar data from the Sentinel-1A mission were processed using the Differential Interferometric SAR (DInSAR) technique to extract both vertical and horizontal displacement components. Simultaneously, 3D surface models derived from LiDAR data provided a high-resolution topographic reference for the affected areas. The results indicate high ground stability during the monitored periods, with minimal displacements recorded within the 1–2 cm range. The integration of these techniques allowed for a holistic stability assessment, where DInSAR provided the spatial continuity and geodetic surveys ensured the local high-precision accuracy. The study demonstrates that while terrestrial methods provide the necessary localized precision, DInSAR offers an essential large-scale view of surface dynamics. Ultimately, this multi-sensor approach provides a robust framework for early risk detection and geotechnical monitoring in complex mining environments.

Key-words: Sentinel 1-A, LiDAR; underground mining; surface subsidence; Chelopech mine

Coseismic Surface Deformation Analysis of the 27 October 2025 Mw 6.1 Balıkesir Earthquake Using Sentinel-1 InSAR Data

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ABSTRACT

The Mw 6.1 earthquake that occurred on 27 October 2025 in the western part of Balıkesir Province,Turkey, caused significant structural damage and ground deformation in the surrounding region. The purpose of this research is to quantify the spatial extent and magnitude of coseismic surface displacements using Sentinel-1 Synthetic Aperture Radar (SAR) data. Differential Interferometric SAR (DInSAR) techniques were applied to ascending and descending orbit images to generate interferograms and displacement maps along the satellite line-of-sight (LoS). The analysis reveals maximum subsidence of approximately −19 cm, with the deformation field exhibiting an elliptical pattern-oriented SE–NW. By combining ascending and descending data, both vertical and east–west horizontal components of crustal displacement were determined, showing dominant subsidence accompanied by westward horizontal motion. The results demonstrate the capability of InSAR to provide rapid, high-resolution measurements of coseismic deformation, which are crucial for understanding tectonic processes and assessing seismic hazard in active regions. The methodology and findings presented here highlight the value of integrating spaceborne radar data in earthquake monitoring and geohazard evaluation.

Key-words: Coseismic deformation; Balıkesir Earthquake; InSAR

The Technology of Close-range Photogrammetry and Terrestrial Laser Scanning - The Basis for the Study, Reconstruction and Rehabilitation of Roads and Road Facilities

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ABSTRACT

The article discusses photogrammetric technologies that allow the creation of three-dimensional models with sufficient accuracy, which can serve both for inspection and as a basis for reconstruction and rehabilitation of roads and road junctions. Their maintenance and preventive inspection are an important element of public security and ensuring safe movement of vehicles on the roads of the republican road network. Close-range photogrammetry allows the creation of orthophotomaps and obtaining a photorealistic and metrically defined image of the condition of the road surface and, supplemented with ground-based laser scanning of structural facilities, allows specifying details when building a detailed model. The article describes the possibilities and features of the combination of the two technologies for obtaining a complete three-dimensional model of a road and road facility. The model is of sufficiently high accuracy, allowing its use both for analysis and as a basis for reconstruction and rehabilitation.

Key-words: Close-range photogrammetry; terrestrial laser scanning; 3D modeling; road infrastructure; reconstruction; rehabilitation; preventive inspection; combined technologies

Algorithmic Approach for Optimization of the Direction of Maximum Dispersion and the Orientation of the Error Ellipse with Respect to the Type and Weights of Measurements in Geodetic Networks

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ABSTRACT

The accuracy of determining the position of points in geodetic networks is described by the error ellipse, resulting from the bivariate normal distribution of coordinates. The influence of the type and weights of measurements on the shape and orientation of the ellipse is of essential importance in combined angular and distance measurements, which are widely used in practice. In this context, determining the orientation of the ellipse with respect to the direction of maximum dispersion is key for the analysis and management of accuracy. In this study, an algorithmic approach is proposed for determining the orientation of the ellipse through analysis of the variance-covariance structure and transformation to the principal axes, which allows unambiguous identification of the direction of maximum dispersion. On this basis, an approach for optimizing the weights in geodetic measurements has been developed, and it has been shown that the appropriate balance between angular and distance measurements allows control over the shape and orientation of the error ellipse and leads to improved accuracy in predefined directions. The scientific contribution of the study consists of integrating the weights of the measurements with the orientation of the error ellipse and the direction of maximum dispersion in a single framework. The proposed approach can be applied in the optimization of schemes for performing geodetic measurements and in the design of networks with predefined accuracy requirements.

Key-words: Error ellipse; maximum dispersion; covariance analysis; weight optimization; angular and distance geodetic measurements; geodetic networks

Automated Multi-Scale Point Cloud Integration for Building Diagnostics Using Terrestrial and Handheld Laser Scanning

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ABSTRACT

The rapid development of digital technologies in civil engineering and architecture has increased the importance of multi-scale three-dimensional data acquisition for structural diagnostics, Building Information Modelling (BIM), and digital documentation of existing buildings. Terrestrial laser scanning provides comprehensive large-scale geometric documentation, while handheld laser scanning enables high-resolution acquisition of localized defects such as cracks, cavities, and surface degradation. However, the integration of these datasets remains challenging due to differences in scale, accuracy, and coordinate systems. This study presents an automated methodology for integrating multi-scale point clouds acquired using terrestrial and handheld laser scanning. The proposed ATHIR (Automated TLS–HLS Integrated Registration) approach enables automatic alignment of high-resolution handheld laser scanning data within a global terrestrial laser scanning reference system while preserving the geometric accuracy of detailed local measurements. The method utilizes reflection-induced voids generated by reflective handheld scanning targets visible as missing regions in terrestrial laser scanning datasets. Instead of treating these gaps as measurement artefacts, the workflow interprets them as geometric features enabling automatic target localization. The developed algorithm combines PCA-based geometric normalization, voxel-grid segmentation, void detection, circle fitting, geometric signature matching, RANSAC filtering, and rigid-body transformation estimation using Singular Value Decomposition (SVD). The methodology was validated on a real building structure affected by visible structural degradation, including wall cracks and material defects. Multi-scale measurements were performed using a Leica RTC360 terrestrial laser scanner and a Shining EinScan Rigil handheld scanner. The results confirmed reliable automatic registration for terrestrial laser scanning point cloud resolutions of approximately 2.2 mm or better. Under these conditions, all reference targets were correctly detected and paired without false positives. The proposed workflow achieved registration accuracies of approximately 0.64–0.71 mm RMSE, demonstrating that high-resolution handheld laser scanning data can be integrated into a global reference frame while preserving sub-millimetre precision. The presented methodology supports automated workflows for structural diagnostics, BIM updating, and digital building documentation. The proposed approach reduces operator dependency and improves the repeatability of measurement-based diagnostics for existing buildings and infrastructure.

Key-words: Multi-scale point cloud integration; terrestrial laser scanning; handheld laser scanning; building diagnostics; automated point cloud registration; structural assessment; BIM

High-Resolution UAV-Derived 3D City Models Supporting Urban Seismic Resilience: A Case Study of Elin Pelin, Western Bulgaria

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ABSTRACT

Advancing urban seismic resilience in conditions of urbanisation increasingly relies on accurate, high-resolution, and up-to-date geospatial information describing the built environment. A high-resolution UAV 3D model serves as the foundational baseline for pre-seismic vulnerability mapping and provides an instant, highly accurate reference for rapid post-disaster damage assessment of any settlement. This study presents an RTK-supported UAV photogrammetric workflow for generating a high-resolution three-dimensional (3D) city model of Gara Elin Pelin, a representative peri-urban settlement in Western Bulgaria. Using a DJI Mavic 3M, 2,856 nadir images were acquired without ground control points and processed to produce a 1.28 cm/pixel orthomosaic, a dense point cloud exceeding 1.24 billion points, a textured 3D model, and a Digital Elevation Model (DEM). These datasets enable the extraction of key building and terrain attributes for building inventories, seismic exposure assessment, emergency planning, and post-earthquake damage assessment. The case study demonstrates that Bulgaria possesses the technical expertise and RTK-supported UAV capability required for high-resolution settlement (urban) mapping. A SWOT analysis and recommendations for integrating nadir and oblique UAV imagery outline future directions for strengthening settlement seismic resilience and the progressive implementation of Digital Building Logbooks (DBL). The proposed methodology offers a scalable and cost-effective solution for municipalities seeking to strengthen earthquake preparedness through high-resolution geospatial data.

Key-words: UAV; UAS; photogrammetry; 3D city (settlement) model; seismic resilience; urban resilience; GIS; Digital Building Logbook

Satellite Ground Receiving Stations for Academic Education and Applied Research

Vesselin Goranov

UVT Sofia Sat Club

ABSTRACT

Satellite data are increasingly important for Earth sciences, environmental monitoring, urban planning, civil infrastructure assessment and risk analysis. However, for many students and young researchers, satellite missions remain abstract systems accessed only through already processed online products. Academic ground receiving stations can bridge this gap by transforming satellite observation into a practical, local and experimentally accessible workflow — from orbital prediction and radio-frequency reception to data decoding, processing, GIS integration and applied interpretation. This presentation discusses the development of a multi-band ground station network by SOFIA SAT CLUB, supported by UVT, with emphasis on its educational and research potential. The network concept includes VHF stations for CubeSat telemetry, satellite operations training and communication fundamentals; L-band stations for weather satellite reception, environmental monitoring demonstrations and practical remote sensing exercises; and future X-band high-data-rate stations for near-real-time Earth observation applications. The proposed approach is especially relevant for academic work in Earth Sciences, Environmental Sciences and Urban Planning. Students can use the stations to study satellite passes, antenna systems, software-defined radio, signal quality, data processing pipelines and the transformation of raw observations into usable geospatial products. Researchers can integrate received data with open satellite archives, GNSS, drone observations, ground measurements and GIS layers to support studies related to fires, drought, floods, vegetation stress, urban heat islands, infrastructure corridors and natural hazard risk. The presentation also outlines a possible model for a university-based ground station integrated into the SOFIA SAT CLUB network. Such infrastructure can support practical courses, diploma theses, doctoral research, municipal pilot projects and interdisciplinary collaboration between geodesy, civil engineering, architecture, environmental science and urban planning. The main argument is that local satellite receiving capacity creates not only data access, but also technical literacy, research capability and applied public value.

Key-words: Satellite ground station; remote sensing; SDR; VHF; L-band; X-band; Earth observation; GIS; urban planning; environmental monitoring; academic education; risk assessment

Geospace-Lithosphere Interactions: Satellite-Based Approaches for Assessing Space Weather Impacts on Geodynamics and Geosystematics

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ABSTRACT

The Earth's lithosphere is increasingly understood not as an isolated boundary, but as an active component of an open, complex thermodynamic system continuously interacting with the near-Earth space environment. This study explores the geodynamic and geosystemic responses of the Earth to external space-weather drivers, focusing on how intense solar activity and geomagnetic storms influence lithospheric stress and seismicity. By utilizing multi-sensor, satellite-based observations—including GPS/Global Navigation Satellite System (GNSS) Total Electron Content (TEC) measurements, thermal infrared (TIR) radiometry, and satellite-based electromagnetic sounders—we examine the physical pathways of the Sun-Earth-Lithosphere connection. Our focus is twofold. First, we analyze the physical mechanisms of electromagnetic triggering, where geomagnetically induced currents (telluric currents) act as a subcritical trigger for slip along highly stressed tectonic faults. Second, we address the critical geosystemic challenge of signal differentiation within the Lithosphere-Atmosphere-Ionosphere Coupling (LAIC) framework. To reliably isolate localized, internal pre-seismic anomalies, researchers must accurately model and filter out global geospace perturbations caused by solar activity. By leveraging advanced spaceborne technologies, we present a systematic methodology to characterize these complex geospace-lithosphere interactions. Integrating space weather dynamics into terrestrial geophysics not only deepens our fundamental understanding of geosystematics but also enhances the reliability of multi-parameter natural hazard monitoring and risk assessment.

Key-words: Geospace; lithosphere; satellite-based approach; space weather impact; geodynamics; geosystematics

From Blast Design to Carbon Footprint: Granulometric Insights into Stiffness Ratio Effects on Limestone Fragmentation in Cement Quarrying

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ABSTRACT

Blast-induced fragmentation is crucial for quarry productivity, especially in preparing raw materials for downstream cement manufacturing. Given that crushing and grinding operations account for a significant proportion of electrical energy consumption and associated carbon emissions, controlling fragmentation at an earlier stage is a key technical strategy in the cement supply chain. The study assesses the influence of varying stiffness ratio on fragmentation performance across five consecutive production blasts in limestone quarry supplying a cement plant (Djebel Safia Quarry, Algeria). The bench height was maintained at 15 m while the burden was gradually reduced, generating stiffness ratio values ranging from 3.57 to 5.36 under comparable field conditions. A detailed granulometric analysis was performed using digital image processing (WipFrag Software) to quantify particle size distribution parameters, including D50, D80, and maximum fragment size. The results reveal a consistent and progressive refinement of fragmentation with increasing stiffness ratio. D50 decreased from 546 mm to 171 mm, while D80 decreased from 1164 mm to 276 mm, accompanied by a significant reduction in coarse fractions. The monotonic particle size response highlights the high sensitivity of production blast fragmentation to adjustments in geometric design. By improving fragmentation uniformity and limiting the generation of oversized blocks, controlling the traction stiffness ratio can improve crushing efficiency and contribute indirectly to reduced energy demand in raw materials for cement. The findings provide field-based evidence demonstrating that decisions regarding blast design go beyond immediate fragmentation outcomes and have a broader influence on the operational and environmental performance in cement-oriented quarry systems.

Key-words: Stiffness ratio; blast fragmentation; granulometric distribution; digital image processing; carbon emissions; cement manufacturing

Effect of Initiation Point (Mid-hole vs Bottom) on Blast Fragmentation: Meftah Limestone Quarry (Blida, Algeria)

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ABSTRACT

Blasting operations at quarries generate large amounts of fragmented rock, and the size of the fragments directly affects the efficiency of loading, hauling, and crushing. While blast design parameters can help predict the theoretical size distribution, digital image analysis provides a quick method to evaluate actual fragmentation results. This study uses WipFrag software to analyze the fragment-size distribution at the Meftah limestone quarry (Blida). The approach involves post-blast photographs taken with a reference scale and automated image processing to determine the particle-size distribution of muckpile fragments. Two field blasts were carried out by changing only the initiation point of the millisecond-delay detonator (MDD): (i) initiation at the midpoint of the blasthole and (ii) initiation at the bottom of the blasthole. The results show that bottom initiation produces finer fragmentation and fewer oversized blocks overall. This behavior is attributed to the geological features of the local limestone, especially bedding/stratification and natural fracturing.

Key-words: Limestone quarry; blasting; fragmentation; WipFrag; particle size distribution; millisecond-delay detonator

Finite Element Evaluation of Slope Stability in Limestone Quarry Operations Under Blasting Conditions

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ABSTRACT

For operational safety and efficiency in limestone quarries, slope stability is essential, especially in settings where production blasting causes dynamic loading. This study combines semi-empirical rock mass classification with field vibration to provide an integrated geotechnical assessment of the limestone quarry at Hammam Sidi El-Hadj, CILAS Biskra, Algeria.slope stability in both static and blast-induced seismic conditions using monitoring and finite element modeling. Good rock quality and stable slope configurations are indicated by rock mass characterisation utilizing rock mass rating (RMR), slope mass rating (SMR), and the geological strength index (GSI). Peak particle velocities (PPVs) ranging from 4.61 to 12.85 mm/s at distances of 150–480 m and frequencies of 3.95–18.54 Hz were found during field monitoring of 20 production bursts. Horizontal seismic coefficients (Ah), which show the dynamic load applied to the slope during blasting operations, were computed using this data. A factor of safety (FoS) of 3.91 under static conditions was obtained from a slope stability analysis using Phase2 finite element software with the Generalized Hoek-Brown (GHB) failure criterion, confirming the slope's intrinsic stability. For the minimum, average, and maximum blast-induced seismic coefficients under dynamic loading scenarios, FoS values dropped to 3.77, 3.46, and 3.18, respectively, indicating decreases of 3.58%, 11.50%, and 18.67%. For Zone 3 conditions (A = 0.15 g), a comparison with the Algerian seismic norm (RPA-2024) produced a FoS of 2.77, signifying a 29.15% decrease. All calculated safety factors remained above critical levels in spite of these reductions, indicating that current blasting techniques preserve appropriate slope stability. Additionally, a linear attenuation relationship between PPV and distance (D) was established by the study, offering a prediction framework for vibration assessment. A reliable, field-validated methodology for evaluating blast-induced slope instability in active quarry environments is provided by the integration of semi-empirical classification, real-time vibration monitoring, and numerical modeling. This helps to promote safer, more sustainable blasting practices in seismically sensitive mining zones.

Key-words: Slope stability; factor of safety; blasting vibration; dynamic loading; PPV (peak particle velocity); PPA (peak particle acceleration); Finite Element Method

Study of Slope Stability under Quarry Conditions, Hadjar Soud, Skikda, Algeria

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ABSTRACT

In the mining sector, slope stability requires knowledge of methods for analysing rock mass stability and empirical methods for classifying rock masses most commonly used in mining. During our study at the Hdjar Soud-Skikda quarry, we noticed a problem with unstable blocks. We focused our study on the quarry on the stability of the benches using two methods for calculating the safety factor, the analytical method and the numerical method. For the analytical method, we calculated the safety factor according to the Bishop and Fellenius methods, with an average of 3,73. For the numerical method, using Plaxis software to validate the results using the finite element method, the safety factor obtained was 3,97. The difference between the two results (analytical and numerical) is considered logical and shows good convergence between the two methods. In both cases, the safety factor is very satisfactory, reflecting a good level of stability of the benches in the quarry. In light of these results, the deposit is generally stable and exploitable in the long term. However, external factors such as heavy rainfall, earthquakes or natural geotechnical changes could influence this stability over time. We therefore recommend regular monitoring of slope stability, particularly in areas that have shown the lowest safety values. It is also advisable to recalculate the safety factor every three to five years, or after any significant change in site conditions, and to use numerical methods in future expansion projects. Finally, it is essential to take into account the effect of groundwater and climate change in future operating plans to ensure continued safety for the site and workers.

Key-words: Quarry; talus Stability; rock massif; analytical method; numerical method

Impact of Iron Mining on the Environment (Rouina Mine, Algeria)

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ABSTRACT

The Rouina iron mine, located in the wilaya of Aïn Defla (north-west Algeria), lies within a sensitive environmental context due to its proximity to agricultural land, the Ouled Mellouk dam, inhabited areas, and the presence of mining residues inherited from the colonial period. This work focused on analyzing the environmental impacts of extractive activities and diagnosing the main mining operations, including blasting, extraction, crushing, and waste rock management, with the aim of proposing appropriate mitigation measures. The study is based on documentation, field observations, soil samples, and the consultation of available data. The results, compared to the reference of the World Health Organization (WHO), highlight several significant impacts: landscape degradation; soil contamination by heavy metals, with lead (Pb) and zinc (Zn) exceeding standards by 2 to 3 times, and arsenic (As) ; dust dispersion generated by crushing and transportation; leaching risks of waste rock towards surface waters; a marked reduction in vegetation cover revealed by the NDVI index; and noise and vibration from blasting, which, although moderate in the short term, present cumulative effects of concern for workers' health and the stability of nearby infrastructures. To mitigate these impacts, an environmental action plan is proposed, integrating technical measures (management and confinement of mining waste, reduction and monitoring of dust emissions), organizational measures (progressive rehabilitation of exploited zones, regular environmental monitoring), and socio-economic measures.

Key-words: Rouina mine , environmental assessment , environmental impacts , heavy metals , mining waste, mine rehabilitation

Contribution to Characterizing Sludge from Wastewater Treatment Plants in Sidi Ali Labhar, Bejaia

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ABSTRACT

With urban and industrial development and changes in water-use patterns, wastewater discharges have significantly evolved in both quantity and quality. Wastewater treatment generates large amounts of sludge, and managing its composition and storage presents technical and environmental challenges for society. These treatment processes produce substantial sludge that must be disposed of. Sewage sludge, a byproduct of these processes, can pose serious environmental and health risks. These sludges contain organic matter, nutrients, and potential pollutants such as heavy metals and chemicals. In this context, this research focuses on falls within the framework of environmental protection by characterizing the sludge from the Sidi Ali Labhar (Bejaia) wastewater treatment plant for potential valorization. To accomplish this, several techniques were employed, including physico-chemical analyses (pH, humidity, and electrical conductivity); a mineralogical analysis using XRD; and a Spectrophotometric Flame Atomic Absorption analysis (SAAF), all conducted in 2019. The results of this study indicate that the physicochemical parameters show that the sludge quality complies with Algerian standards, with pH = 5.59, humidity = 76.71%, and electrical conductivity = 5.02 mS/cm. Additionally, mineralogical analysis by DRX reveals the presence of Quartz (SiO2) and various carbonate structures: Calcite (CaCO3), Dolomite (CaMg(CO3)2), l'illite (K, H3O)(Al, Mg, Fe)2(Si, Al)4O10[(OH)2, (H2O)], and anhydrite (CaSO4). Furthermore, according to SAAF's results, the sludge contains heavy metals such as Fe, Cd, Cu, Cr, Pb, Zn, Ni, and Mn, with concentrations below the maximum limits allowed by the Algerian standard.

Key-words: Wastewater sludge; environment; characterizing; pH; DRX; Bejaia

Studying the Nonlinear Bond Behavior of Steel Rebar Concrete Experimentally and Numerically Using JH-II Model

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ABSTRACT

This study investigates the complex interaction between ribbed steel rebar and concrete in pullout tests, focusing on high strain rates and the critical characteristics of the steel-concrete interface. The strain rate during pullout tests is high, making it essential to model the bond behavior between ribbed rebar and concrete accurately. The JH-II model is selected for simulating concrete behavior, as it effectively captures high-strain-rate effects and concrete's quasi-brittle fracture mechanics. In parallel, a ductile damage model is employed to represent the steel's response, as strain rate is a crucial factor in the steel-concrete interaction. Nine pullout test specimens were prepared using three different mixes: a C25 mix with natural aggregates, a mix with 50% recycled aggregates, and a mix with 100% recycled aggregates. The steel rebar, with a bond length five times its diameter of 16 [mm], was used in all specimens. The impact of the aggregate replacement ratio on the bond-slip behavior is discussed, and the study further explores how different replacement ratios affect the steel-concrete bond behavior. A parametric study was conducted to optimize the JH-II model parameters for concrete using experimental pullout data, and the relations between the JH-II model parameters and the experimental results were discussed.

Key-words: Reinforced concrete; ribbed steel; bond behavior; FEM; JH-II

Adaptive Reuse vs. Demolition in the Life Cycle of Real Estate

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ABSTRACT

The management of construction and demolition waste (C&DW) is a critical aspect of sustainable real estate development, directly affecting environmental performance, economic feasibility, and regulatory compliance. This study investigates the comparative impacts of adaptive reuse versus demolition and new construction within the life cycle of real estate, focusing on atypical or non-standard properties such as former industrial buildings, warehouses, and churches. The purpose of this research is to evaluate both the environmental and economic outcomes of these approaches while considering legislative and policy frameworks, market conditions, and the potential for circular economy integration. Recent amendments to the Polish Waste Act impose stricter requirements for the selective collection, segregation, and preparation of C&DW for reuse and recycling. These changes align with European Union directives, including the Waste Framework Directive (2008/98/EC) and the planed EU Circular Economy Act, which promote high recycling rates and the adoption of circular economy principles across member states. The legislation affects real estate investment decisions, and has an influence on the choice between adaptive reuse and demolition based on environmental, economic, and regulatory considerations. The study utilizes a combination of life cycle assessment (LCA) and life cycle costing (LCC) approaches to evaluate the environmental and financial trade-offs of each strategy. Key parameters analyzed include capital and operational costs, waste generation, carbon emissions, regulatory complexity, and market risk. The findings indicate that adaptive reuse generally results in significantly lower waste generation and carbon emissions, as well as preserving embodied materials and reducing the demand for virgin construction resources. It also provides added benefits, including the conservation of cultural and historical value, alignment with sustainability goals, and an enhanced public perception of environmentally responsible development. Despite these advantages, the research highlights that the economic viability of adaptive reuse is highly dependent on context. High upfront costs related to structural reinforcement, contamination remediation, and compliance with regulatory standards can reduce financial attractiveness. Moreover, the lack of well-developed secondary material markets and uncertainties in cost recovery further constrain profitability. In contrast, demolition and new construction may offer greater design flexibility, shorter project timelines, and potentially lower immediate costs, although this approach typically generates larger volumes of waste, higher carbon emissions, and increased disposal costs. The study concludes that decision-making in the life cycle of real estate should adopt a holistic, integrated approach that balances environmental, economic, and regulatory considerations. Early incorporation of LCA and LCC methods into project planning enables developers, investors, and policymakers to optimize trade-offs between sustainability and financial feasibility. Regulatory support, the development of secondary material markets, and clear guidelines for construction waste management are essential to increase the competitiveness of adaptive reuse strategies. While adaptive reuse offers superior environmental performance and aligns with circular economy objectives, demolition may remain economically preferable under certain technical or market conditions. The research emphasizes that systematic planning, regulatory incentives, & innovative waste management practices are crucial to achieve sustainable outcomes across life cycle of real estate assets.

Key-words: Construction and demolition waste; life cycle assessment; life cycle costing; sustainable construction; atypical properties

Composite Steel Trussed Concrete Beam Behavior in Different Truss Schemes and Geometry

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ABSTRACT

The paper examines composite steel trussed-concrete beams, an innovative structural solution well-suited for long-span constructions. While the steel truss provides substantial strength and stiffness, it also presents certain challenges. Originally developed in Italy, this technology has become increasingly widespread, particularly in its country of origin. Several companies around the world are now designing, manufacturing, and marketing these beams, including MELALRI, which produces “MTR” beams, the Italian manufacturer Tecnostrattor, known for their “NPS” and “REP” beams and TR Technology producing “TTR” beams. These beams are typically designed in the shape of a Warren truss. The primary objective of this study is to explore and compare various truss configurations, such as Pratt, Howe and Warren trusses, and to analyses their impact on reinforcement requirements in composite structures, load distribution, and overall structural behavior. Different truss designs require different reinforcement strategies to optimize shear resistance, flexural strength, and ductility. To manage shear stresses, vertical stirrups are used, while horizontal rebars address bending stresses; in some cases, a steel plate is added at the bottom to enhance bending resistance. Our findings indicate that each truss shape requires a customized reinforcement approach to maximize structural performance.

Key-words: Composite beams; truss reinforcement; prefabricated beams

Student Perspectives on Artificial Intelligence Integration in Construction Education

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ABSTRACT

Artificial intelligence (AI) is becoming an important part of construction practice, particularly in areas such as scheduling, safety, estimating, and decision-making. As these tools become more common, there is a need to understand how students are learning about AI and how prepared they feel to use it in real-world situations. This study examined student perspectives on AI in construction education, focusing on their exposure to AI tools, patterns of use, and approaches to evaluating AI-generated results. A structured survey was developed to capture student experiences with generative AI and other AI-based tools used in construction. The survey also examined how students respond when AI outputs conflict with their own understanding, including whether they verify, adjust, or accept those results. In addition, the study investigated student perceptions of preparedness, preferred methods for learning AI (such as integrated modules or dedicated courses), and the areas in which they perceive AI to be most valuable. It also considered student views on responsible AI use, including awareness of limitations and concerns related to over-reliance. This work was intended to identify gaps in current educational practices and to provide insights for integrating AI into construction curricula in a manner that supports learning, critical thinking, and professional judgment.

Key-words: Artificial intelligence; construction education; student perception; AI literacy; decision-making

Modern Methods of Construction as a Way to Reduce Construction Waste in The Context of a Circular Economy

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ABSTRACT

Currently, the AEC industry (Architecture, Engineering, and Construction) offers many material and design options for the design, production and implementation of buildings. Great emphasis is placed on buildings with environmental aspects that save the environment, while meeting all norms, standards and requirements of even the most demanding customers. Modern methods construction based wood meet all these attributes. In addition, they have significant environmental benefits, as they leave a low ecological footprint throughout the entire life of the building. Modern methods construction based wood can be classified as fast and ecological construction, because wood as a renewable raw material offers many advantages for the construction industry. One of them is the reduction of construction waste. Moreover, the construction waste generated in this way can be reused and recycled. These three approaches represent the three principles (3R) of the circular economy. The paper devotes to the analysis of the modern methods construction based wood on site and off site options. The aim of the paper is to identify the type and source of construction waste for selected structural systems of wooden constructions (beam, panel, modular and log), which differ in the degree of industrialization and prefabrication. They can be manufactured under controlled conditions in production halls (off-site) and only assembled on the construction site, or manufactured and assembled on the construction site (on-site). Based on analytical knowledge, hypotheses are defined regarding the amount of construction waste, the place of its origin and the influence of the structural system of wooden buildings on the generation of construction waste. The conclusions of the paper were determined based on the frequency of waste generation in the studied areas, which provided the basis for the processing of the hypotheses.

Key-words: construction, modern methods construction-based wood, construction waste, production, realization

Artificial Intelligence, BIM, and Circular Economy in Construction: Economic Implications and Industry Adoption

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ABSTRACT

The integration of Artificial Intelligence (AI) and Building Information Modelling (BIM) within the circular economy framework represents a transformative shift in construction industry practices and economic performance. This paper investigates the perception, adoption levels, and economic implications of AI and BIM implementation in the construction sector, with a focus on circular economy principles. The research is grounded in empirical data collected through two questionnaire surveys conducted in 2024 and 2025 targeting construction professionals in Slovakia. The surveys assessed AI utilization levels, digital competencies, perceptions of AI impact across construction lifecycle phases, and the economic importance of AI-supported processes. Results indicate that AI utilization levels remain relatively low but show a positive trend between the survey periods (mean 2.03/5 in 2024 vs. 2.31/5 in 2025). In 2024, the highest AI impact expectations were identified for the facility management phase (mean 3.82/5), cost management (mean 3.67/5), and schedule optimization (mean 3.61/5). The 2025 survey revealed that cost monitoring, schedule planning, and client satisfaction are the most critically valued performance indicators (means above 4.1/5), while AI training levels among professionals remain low (mean 1.83/5). The findings highlight a persistent gap between the recognized potential of AI and BIM and their actual adoption, particularly in circular economy-related areas such as waste management and materials optimization. The study underscores the need for targeted training initiatives and strategic frameworks to accelerate AI and BIM integration in support of circular construction economics.

Key-words: Artificial intelligence; BIM; circular economy; construction industry; digitalization

The Use of Composite Materials to Increase the Earthquake Resistance of Stone Structures

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ABSTRACT

The results of experimental studies to assess the seismic resistance of stone walls of buildings made of ceramic bricks and cellular concrete blocks, taking into account their reinforcement based on the use of carbon fiber composite materials, are present-ed. Two design options are considered: a two-story fragment of a building made of ceramic bricks, and a full-size wall panel with a window opening mounted from cellular concrete blocks. Tests for seismic impacts with an intensity of 6-10 points on the MSK-64 scale were carried out on a two-component vibration plat-form. During the tests, the level of vertical load on the experimental samples was simulated. According to the obtained hysteresis curves, the moments of the beginning of the process of destruction of the samples were revealed. Various schemes of brickwork reinforcement were modeled on the 2-storey brick fragment. During the tests, the amplitude-frequency spectrum of the effects varied in the range from 1 to 15 cm at a frequency from 1 to 20 Hz. When exposed to resonant frequencies, structures that were not reinforced with composite material were damaged, leading to the collapse of the samples. In the case of testing samples reinforced with composite material, individual cracks were detected in the samples, but no progressive structural collapse occurred. Recommendations are given on the use of carbon fiber composite materials to strengthen structures operated in earthquake-prone regions.

Key-words: Composite materials, structure resistance, earthquake

Evaluation of the Anti-Aging Performance of AC-20 Asphalt Binder Modified with Industrial and Nano-Grade Titanium Dioxide (TiO2)

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ABSTRACT

Asphalt concrete is the primary material used in road pavement construction; however, increasing traffic volumes and extreme climatic conditions—such as high temperatures and heavy rainfall—frequently lead to pavement damage and a reduction in service life. This study investigates the effectiveness of incorporating titanium dioxide (TiO2) into AC-20 asphalt binder to mitigate the effects of ultraviolet (UV) aging. Two types of TiO2, industrial-grade and nano-grade, were added in proportions of 0%, 2%, 4%, 6%, and 8% by weight. Samples were subjected to UV irradiation for durations ranging from 0 to 144 hours. The aging characteristics were evaluated through penetration and viscosity tests. Furthermore, Scanning Electron Microscopy (SEM) and optical microscopy were employed to analyze the micro-morphological changes on the asphalt surface. The results demonstrate that the addition of significantly inhibits the oxidative effects of UV radiation compared to the control group (0% TiO2). These findings suggest that modification is an effective strategy for enhancing the durability and extending the service life of asphalt pavements.

Key-words: Asphalt glue; viscosity test; penetration test; asphalt concrete; asphalt aging

Sustainable Asphalt Technologies in Road Pavements

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ABSTRACT

Road pavements constructed from asphalt mixtures represent a significant part of transport infrastructure. The production, transport, and laying of asphalts consume large amounts of natural raw materials and energy resources. The most significant environmental impact occurs during the production of the asphalt mixture (modules A1 to A3 of the Environmental Product Declaration system, EPD, which includes the extraction and transport of raw materials and the production of the asphalt mixture at the production plant), with energy consumption for heating the aggregate and bituminous binder being the dominant factor. This is followed by logistics from the asphalt plant to the construction site and the conditions during laying and compaction (modules A4 and A5 of the EPD system). Sustainable asphalt technologies are currently a key tool for reducing the environmental impact of road infrastructure while maintaining the required technical level and service life of roadways. The paper focuses on comparing standard hot-mix asphalt HMA mixtures and low-temperature WMA mixtures produced using low-temperature additives and foamed asphalt technology in the context of technical requirements and environmental assessment. Attention is paid to the possibility of reducing production temperatures by 10, 20, and 30°C and the impact on environmental life cycle indicators. The compaction results demonstrated the effectiveness of Licomont BS100 (3%) and CWM (0.4%) additives in reducing the compaction temperature from the reference 150°C to 140-130°C. At a temperature of 120°C, there is already a visible deterioration in compaction resistance, voids content (above 7%) and bulk density (decreased by 0.052 kg.m-3), which limits further temperature reduction. The evaluation includes an assessment of mechanical properties, asphalt stiffness modulus and indirect tensile strength on cylindrical samples. Laboratory tests have shown that foamed asphalt technology, production and compaction at a reduced temperature of 135°C provide comparable parameters to conventional hot-mix technologies, with a difference in stiffness modules of 8.0% and in strength of 6.7% determined at a temperature of 20°C, with slightly increased ductility. This indicates potential for their use in practice, especially in cases where better resistance to cracks and fatigue is required without significant compromise in the load-bearing capacity of the pavement. Experimental verification confirmed that foaming technology and combination with low-term additives leads to a synergistic effect reducing dynamic viscosity by 15% to 20%, which significantly facilitates compaction at lower temperatures. The conclusion of the paper emphasizes the importance of implementing these solutions into the road management system (RMS) as a necessary step towards achieving the goals of carbon neutrality and sustainable development in transport construction.

Key-words: Warm mix asphalt; foam asphalt; environmental product declaration; compactibility; stiffness; strength

The Use of X-Ray Tomography in Assessing the Homogeneity of Foamed Asphalt Mix Containing Rap

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ABSTRACT

The implementation of sustainable management principles and environmental requirements aimed at reducing greenhouse gas emissions is driving the development of new materials and technologies. In road construction, the most energy-intensive material produced at high temperatures ranging from 165°C to 180°C is mineral-asphalt mix. During its production, large quantities of greenhouse gases, particularly CO2, are emitted. To meet current requirements, mixtures with reduced production and laying temperatures have been developed – Warm Mix Asphalt (WMA) and Half Warm Mix Asphalt (HWMA). These are characterized by significantly lower production and laying temperatures compared to traditional mineral-asphalt mixtures. HWMA is the more effective of the two, as its production temperature is reduced by approximately 45–50°C compared to that of a traditional mineral-asphalt mix. Within the HWMA group, the most environmentally friendly is Foamed Asphalt Mix, which is produced using water-foamed asphalt. It is also advisable to use RAP in the composition of mineral-asphalt mixtures, thereby reusing material from the asphalt layers of road pavements. Road modernization aimed at improving load-bearing capacity and driving comfort results in the generation of ever-increasing quantities of RAP, the utilization of which poses a problem. The study utilized an AC 16W Foamed Asphalt Mix, the composition of which included foamed asphalt, which contained foamed bitumen modified with 1.5% synthetic wax with a reduced carbon footprint and 0.4% tall oil amidopolmines. The AC 16W mix contained 0%, 20%, 40% and 60% RAP, respectively, by weight relative to the aggregate used in its composition. The conventional AC 16W mix was produced at 165°C and the FAM with RAP at 120°C. The physical and mechanical properties of the tested mineral-asphalt mixtures were examined in terms of void content, resistance to water and resistance to permanent deformation. The FAMs exhibited comparable properties to the traditional mineral-asphalt mixture. A very important issue related to the quality assessment of FMA with RAP is the evaluation of their homogeneity. For this purpose, X-ray computed tomography (X-ray CT) was used to analyze the internal structure. Based on the tests carried out using image analysis software, it was found that all the FAMs tested, regardless of the amount of RAP used, are characterized by structural homogeneity.

Key-words: Foamed asphalt mix; X-ray CT; internal structure; RAP; synthetic wax; tall oil amidopolyamines

Additive Construction on Military Installations: Applications, Strategic Impact, and Future Directions

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ABSTRACT

Additive construction, which is the use of 3D printing to build structures layer by layer with automated equipment and cement-based materials, is a new technology used by the U.S. military for temporary housing, protective structures, and field infrastructure. This paper reviews additive construction in the military, covering key programs such as ACES and partnerships with ICON, case studies at Fort Bliss and Camp Swift, and its use across different climates. It looks at benefits such as faster construction, reduced manpower, improved safety, and stronger supply chains, as well as challenges such as material consistency, structural support, regulatory compliance, and moving equipment. The paper also discusses how additive construction can improve military readiness, reduce costs, and make bases more resilient, and considers future developments such as digital twins, AI design, and autonomous construction. The findings show that additive construction can significantly improve military infrastructure if current challenges are addressed through research, new standards, and service coordination.

Key-words: Additive construction; 3D printing; military housing; expeditionary structures; infrastructure resilience

Assessment of Damage to Residential Buildings After UAV Impact

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ABSTRACT

The aim of the study is to develop a sequence for the engineering assessment of damage to residential buildings after UAV impact, taking into account the effects of an explosion, blast wave, fragments, fire, and the subsequent redistribution of internal forces within the structural system. The relevance of the topic is determined by the need for a rapid but well-grounded assessment of the technical condition of buildings, the boundaries of emergency zones, the residual load-bearing capacity of structures, and the risk of progressive collapse. The material basis of the study consists of the results of visual and instrumental inspections of damaged residential buildings, photographic documentation of destruction, analysis of defect patterns, geodetic measurements, and data from full-scale testing of individual structural elements. The assessment methodology involves the classification of damage according to the impact location and its structural consequences. The main scenarios include damage to floor slabs, façade panels or external walls, the roof covering or upper level of the building, the technical floor, end and corner zones, as well as the consequences of an explosion near the building without direct impact on load-bearing elements. The greatest engineering hazard is posed by damage that affects slab support nodes, joints between structural elements, the performance of end and corner zones, as well as elements additionally exposed to fire. Even local defects in such zones may cause systemic consequences for adjacent storeys or a separate building section. The assessment should include verification of the preservation of the main load transfer paths, joint functionality, spatial stiffness, and conditions that may contribute to the development of progressive collapse. The results of the analysis make it possible to distinguish two main directions of engineering decisions: demolition of emergency fragments or implementation of emergency stabilization measures with temporary strengthening of structures. The integrated combination of visual inspection, instrumental measurements, geodetic control, deformation monitoring and, where necessary, numerical modelling provides a basis for justified decision-making regarding safe operation, conservation, restoration or dismantling of damaged structures.

Key-words: UAV impact; technical inspection; progressive collapse; stability; emergency stabilization measures

Engineering Assessment and Building Stabilization After UAV Impact

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ABSTRACT

The aim of the study is to develop an engineering sequence for assessing the technical condition and stabilization of residential buildings after local blast impact caused by UAV strike. Particular attention is paid to precast reinforced concrete panel buildings, for which the preservation of spatial stiffness depends on the combined performance of longitudinal and transverse load-bearing walls, inter-panel joints, and floor slab support zones. Local failure of these elements may disrupt load transfer paths and create prerequisites for progressive collapse. The research methodology includes a preliminary inspection of the building, identification of hazardous areas, detailed visual survey, photographic documentation of damage, measurement of defects, preparation of damage schemes, instrumental determination of concrete strength using non-destructive methods, and analysis of the actual behaviour of the structural system. The main criterion of engineering hazard is not only the presence of visible damage, but also its influence on the integrity of the load-bearing system, the performance of joints, support nodes, and the possibility of maintaining the spatial stability of the building. According to the inspection results, the main damage was concentrated on the lower storeys between adjacent residential entrances. The collapse of the external load-bearing wall, damage to adjacent wall sections, failure of the internal transverse wall, out-of-plane deformation of the longitudinal load-bearing wall, collapse of floor slabs above the first and second storeys, and the hanging condition of a separate floor slab were recorded. This combination of defects indicates disruption of the normal performance of vertical and horizontal load-bearing elements and the need for urgent emergency stabilization measures. The adopted structural and technological solutions provide for the installation of temporary steel strengthening structures within the damaged zone. Their purpose is to form an alternative load transfer path, reduce the risk of further collapse, ensure the possibility of dismantling emergency fragments, and create safe conditions for subsequent restoration works. The proposed sequence of actions can be used as a methodological basis for the assessment, stabilization, and preparation for the restoration of residential buildings damaged by local blast impacts.

Key-words: Technical inspection; stability; emergency measures; fire; progressive collapse

Numerical Modeling of UAV-Impacted Buildings

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ABSTRACT

The aim of the study is to assess the post-emergency condition of a multi-storey residential building after UAV impact using spatial numerical modelling. The object is a residential building in Kyiv with damage within the 4th-6th storeys, including the destruction of external walls, fragments of monolithic reinforced concrete floor slabs, and vertical load-bearing elements. The finite element model developed in LIRA-FEM includes two calculation states - before and after the impact, with the removal of destroyed elements. The obtained results characterize changes in load transfer paths, redistribution of internal forces in slabs and pylons, as well as the formation of prerequisites for progressive collapse. The integrated approach provides a basis for identifying emergency zones and selecting emergency stabilization measures.

Key-words: Stability; LIRA-FEM; technical survey; blast load; progressive collapse; emergency stabilization measures

The Internal Structure of Asphalt Mixtures Samples in Terms of Their Production and Compaction Technology

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ABSTRACT

The internal structure of asphalt mixtures is an important parameter that can significantly influence their properties. It primarily refers to the distribution and interconnection of air voids, as well as the arrangement and interlocking of aggregates. Unfortunately, this aspect is overlooked in asphalt mix design. To date, it has not even been sufficiently explored. It is assumed that the internal structure of asphalt mixture samples is strongly related to the compaction method and production technology used. This theory has not been confirmed by a sufficient amount of research. Efforts are currently being made to reduce the environmental impact of the production and paving of road materials as much as possible. New solutions are being sought that will ensure adequate durability of the surface with the least possible harmful impact. Most often, this impact is reduced by lowering technology temperatures. WMA asphalt mixtures are being introduced into the industry. They successfully replace traditionally produced mixtures, without adverse effects on the durability of the construction. The reduction of technological temperatures is achieved, among others, by using appropriate additives or foamed asphalt technology. It therefore seems very important to verify how the use of this technology affects the internal structure of the mixture. Additionally, previous work has shown that the formation of this structure is also influenced by the method of sample compaction in the laboratory. Therefore, this paper attempts to demonstrate how the compaction method and production technology of asphalt mixtures shape and influence their internal structure. To achieve this, the paper contains test results for AC 11 S asphalt concrete produced using both HMA and WMA technologies. To lower process temperatures, WMA mixtures were produced using the additive of Fisher-Tropsh wax. The mixtures did not differ in terms of grain size so as not to add another variable. The mixtures in both technologies met the technical guidelines described in WT-2 2014. In addition, samples produced in the laboratory were compacted using two methods: impact and rotational. These samples were cylinders with a height of approximately 63.5 mm and a diameter of 100 mm. The analysis of the internal structure of the mixtures was performed using the x-ray CT method. This method allowed the creation of 3D models of samples that were analyzed in selected zones without the need for physical cutting. Detailed analysis included creating the distribution of air pores in terms of their volume and the distribution of pores in the sample volume, creating 3D models of air voids and observing their connections. The obtained results were compared in terms of the technology of producing asphalt mixtures, as well as the methods of forming samples

Key-words: Warm mix asphalt; compaction technology; production technology; internal structure; X-ray CT method

Nano-Geotechnics and Transformative Changes in Modern Geotechnical Engineering

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ABSTRACT

The concept of nanotechnology has been widely discussed across various fields for many years. In the realm of geotechnical engineering, numerous studies have been conducted in laboratory settings. However, the key question remains: what impact does nanotechnology have on modern geotechnical engineering? Previously, particles were often classified under a single label, such as stabilizers. Today, a new world has emerged in geotechnical engineering, a world that differentiates particles by size: macro, micro, nano, and sub-nano. Each of these particles exhibits distinct effects on soil behavior. Moreover, these effects are not limited to soils alone; they extend to the performance of all construction materials. Accordingly, this paper provides an evaluation of the various applications of particles across different size scales and their roles in diverse geotechnical engineering practices.

Key-words: Nano-Geotechnics (NaG), Nano Soil Improvement (NSI), nanotechnology, geotechnics

Application of Bayesian Hyperparameter Optimized XGBoost Model for Clayey Soils Compression Index Prediction

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ABSTRACT

This research presents an innovative predictive model for the compression index of clay soils that employs Bayesian optimisation (BO) and eXtreme Gradient Boosting (XGBoost). Initially, the developed BO-XGBoost model is constructed and validated using a database that contains more than thousand samples from various locations worldwide. The precision of the BO-XGBoost model was assessed using all regression metrics. The model's generality and efficiency were evaluated by calculating these measures across the training and testing datasets. The study results were unequivocal: The integrated BO-XGBoost model surpassed other leading machine learning and deep learning models in estimating the compression index of clayey soils. Lastly, the permutation method was employed to conduct a feature importance analysis and ascertain the influence of various input features on the compression index of clayey soils. As evidenced by the results of the feature importance analysis, this latter was significantly impacted by the initial void ratio, plasticity index, and liquid limit.

Key-words: XGBoost; Bayesian optimization; compression index; clayey soils

Shear Wave Velocity for Geotechnical Characterization of Granitic Massifs

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ABSTRACT

This study presents the characterization of a geomaterial mass in Covilhã (Portugal) using in situ testing, focusing on the Seismic Piezocone Penetration Test (SCPTu). The results provided information on mechanical strength, internal structure, and geotechnical properties, enabling a more reliable assessment of subsurface conditions. Soil classification indicates sand to silty sand with high and increasing overconsolidation ratio (OCR) and relative density, suggesting a tendency toward cementation. SCPTu proved effective for estimating initial stiffness and deformation moduli, improving the interpretation of soil mechanical behavior for geotechnical design. Geotechnical characterization of soils and rock masses is essential for foundation and underground engineering. While laboratory tests such as triaxial tests have traditionally been used to determine soil mechanical properties, in situ methods are increasingly adopted due to their speed, efficiency, and ability to provide continuous subsurface profiles. Efforts have been made to enable in situ tests to estimate parameters commonly derived from laboratory testing. In practice, engineering projects often combine field data with laboratory analyses through empirical correlations. Field approaches offer advantages such as rapid execution and lower cost, but they also require calibration and may be less reliable for poorly studied materials such as residual, contaminated, or artificial soils. Dynamic penetration tests have long been used due to their simplicity and global standardization. More advanced techniques include the Cone Penetration Test with pore pressure measurement (CPTu), recognized for its reliability and cost-effectiveness. The Seismic Cone Penetration Test (SCPTu) expands this method by incorporating seismic sensors that measure shear wave velocity (Vs), a key parameter for estimating soil stiffness and deformation properties. Recent developments have further extended cone penetration systems by incorporating sensors capable of measuring electrical resistivity, conductivity, pH, and fluid-phase ions, as well as fluorescence detection using optical fibers. These advances have broadened applications to environmental investigations, particularly for detecting subsurface contaminants. However, such studies often require specialized equipment and experimental test sites that may not always be available. SCPTu integrates seismic measurements with conventional CPT parameters, enabling simultaneous evaluation of cone resistance, pore pressure, and shear wave velocity. This combination provides a comprehensive characterization of subsurface conditions and supports more reliable geotechnical design. The present study investigates the geotechnical characterization of a geomaterial mass at the Tortosendo Industrial Park, Covilhã (Portugal), based on SCPTu testing. The results are compared with empirical correlations, laboratory-based interpretations, and preliminary CPTu data to evaluate the advantages and limitations of in situ methods. A testing program including CPTu and SCPTu was implemented to characterize the geomaterial mass. Test execution proved challenging due to anchoring difficulties, limited reaction

capacity, and the measurement range of the load cells for this type of material. As a result, continuous profiles of cone resistance (qt), sleeve friction (fs), and pore pressure (u) were obtained only at shallow depths (approximately 3–4 m). Despite these limitations, the soil was classified as sand to silty sand with high and increasing relative density (Dr) and overconsolidation ratio (OCR), indicating a transition toward cemented behavior. Pore pressure measurements below the groundwater level showed negative values, reflecting the dilative response typical of dense granular soils. The friction angle (ϕ) estimated from classical correlations yielded relatively high values. This likely reflects the combined influence of frictional resistance, dilatancy, and slight apparent cohesion associated with residual bonding between mineral particles.

Key-words: In situ testing; geotechnical engineering; SCPTu; geomechanics

Biochar and Almond Shell Powder as Sustainable Soil Improvement Alternative to Geotextiles

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ABSTRACT

Rapid urbanization and population growth have significantly increased the demand for effective soil improvement techniques. This demand has encouraged the development of alternative ground improvement methods that address both economic and sustainability concerns. One widely used approach is the use of fiber-based geotextile reinforcements, which can be mixed with soil to enhance its mechanical properties. However, the effectiveness of fiber reinforcement is often limited due to challenges related to fiber orientation and distribution within the soil matrix. In addition, most geotextile products are petroleum-based, which raises sustainability concerns. In this context, agricultural waste materials with fibrous or cementitious characteristics may provide a sustainable alternative for soil reinforcement. In this study, biochar and almond shell powder, both derived from agricultural waste, are proposed as environmentally friendly additives for improving the shear strength of granular soils. Preliminary studies indicate that these materials can contribute to strength enhancement through particle interlocking and cementitious behavior. The shear strength performance of soils reinforced with almond shell powder and biochar is experimentally investigated through direct shear tests. The results are compared with various reinforcement materials using empirical relationships available in literature. Based on the experimental findings, the efficiency of the proposed sustainable materials is evaluated in comparison with conventional geotextile reinforcement.

Key-words: Direct shear test; almond shell powder; biochar; soil improvement

Elastoplastic Finite Element Analysis of Tunnel Stability and Support Performance under Blast-Induced Rock Mass Degradation: A Case Study of the Sidi Aich Tunnel, Algeria

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ABSTRACT

The Sidi Aïch highway tunnel in northern Algeria passes through weathered squeezing marl, where tunnel stability is strongly influenced by both excavation-induced stress redistribution and the progressive degradation of the surrounding rock mass. Although the V3 support system was originally selected for poor ground conditions, its performance under the combined effects of excavation and nearby blasting activities has not previously been evaluated. This study presents an integrated elastoplastic finite element analysis to assess tunnel stability and the structural performance of the V3 support system for a 10 m section of the left tunnel between chainages LK40+340 and LK40+350. The rock mass was initially classified as RMR = 29 (Class IV) according to Bieniawski's Rock Mass Rating system. To represent the influence of repeated blasting, a damage factor (D = 0.4) was introduced into the numerical model, reducing the rock mass stiffness and cohesion and lowering the operational classification to RMR = 19 (Class V). A two-dimensional finite element model developed in Phase2 (Rocscience v8.0) simulated the complete NATM excavation sequence through eight construction stages. The results showed that blast-induced degradation increased the maximum wall convergence from 10.5 cm to 14.2 cm, while the maximum floor heave increased from 34.95 cm to 41.5 cm. The maximum total displacement reached 44.8 cm, with the largest deformations occurring before invert closure. Although blasting increased the structural demand on the support system, the V3 configuration remained within acceptable safety limits, and tunnel deformation stabilized after completion of the support ring. The findings highlight the importance of accounting for blast-induced rock mass degradation in the numerical assessment of tunnels excavated in squeezing marl and confirm the effectiveness of the V3 support system when timely support installation and early invert closure are adopted.

Key-words: Tunnel; RMR; blasting vibrations; Elastoplastic Finite Element Analysis; Rock Mass Degradation; NATM; Phase2; V3 support

Impact of Emerging Technologies on Construction Safety Performance: A Literature Review

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ABSTRACT

When it comes to the adoption of digitalization, the construction industry is far behind many industries. It is famous for its low adoption of emerging technologies, and that is why this industry is facing issues like low production rate, lower profitability, and higher cost overruns. Also, the situation is even worse when it comes to safety. The issues this industry currently has are a high number of accidents, high fatality rates, absence from work, and many others. Recently, a term construction 4.0 has emerged as a remedial to lower digitalization adoption in this industry. It includes various recent technologies, including Artificial Intelligence (AI), Building Information Modeling (BIM), real-time location system (RTLS), and computer vision (CV). Every other advanced technology has its different role in safety. There are various benefits of the adoption of recent technologies, which can work for the advancement of the construction industry as well betterment of safety. This study has included a thorough literature review regarding the impact of these recent technologies on the safety performance of the construction industry. This study will provide a comprehensive review of the current adoption, absence of these technologies, and how many benefits this industry can get with the implementation of digital technologies.

Key-words: Digitalization; construction Industry; BIM; computer vision; artificial intelligence

Human-Centered Design Principles in the Transformation of Contemporary Urban Square: Trg Austrije in Sarajevo

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ABSTRACT

The purpose of this research is to investigate how the principles of human-centered urban design contribute to the quality and routine usage of today's public squares. Shifting attention from a single point of reference to pedestrian priority, human scale, micro-experiences, comfort, and psychological perception, the study explores how these principles can be interpreted to develop spatial parameters that make for a meaningful public life. The study draws from literature on public space quality, pedestrian behavior, spatial publicness, and experiential urban design. As a result of this synthesis, a series of spatial criteria have emerged, emphasizing movement, staying, safety, legibility, and time spent in space as primary indices of successful public squares. These criteria are subsequently tested using an applied case study of Trg Austrije square with a design proposal that acts as a spatial validation of the principles studied, but not an independent design objective. This accumulation of everyday micro-experiences facilitates that quality, while the pedestrian-oriented structure, transitional spaces, and comfort-enhancing elements such as seating, greenery, and lighting enable the solution that creates these high-quality public spaces. The research findings suggest ways in which human-centered design approaches are critical in contemporary re-structuring of urban squares for contexts which require that public space accommodate movement, social interaction, and psychological comfort. The results provide generalizable lessons learned for the design of public spaces other than those in the current case.

Key-words: Human-centered urban design; public space quality; human scale; urban perception; place identity

Tends in Post-War Urban Reneval: The Example of Ukraine

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ABSTRACT

Abstract. The war in Ukraine has caused large-scale transformations in the urban environment that are beyond the totally physical destruction of buildings and infrastructure. Not only structures and communications have been affected, but also social ties, everyday prac-tices of using space, institutional mechanisms of city management, and cultural memory - heritage. In these conditions, the restoration of cities is not a matter of recreation of the previous state, but a complex process of spatial and social transformation that requires a balance between immediate needs and long-term strategies for sustainable development. The purpose of this study was to reaserch the international experience of the post-war reconstruction, adapt its principles to the Ukrainian context, and test the methodology on specific examples in Kharkiv and Mariupol.This research is based on the spatial-social analysis that combines methods from the urban studies, architecture, sociology and analysis of the cultural heritage . This approach makes it possible to consider reconstruction not only as a technical process, but as a systemic transformation of urban structures that shapes new approaches to life, memory, and spatial justice. The results of the study is development of conceptual model of post-war restoration of urban structures in Ukraine based on spatial and social analysis. Such a model should combine the architectural and planning solutions with the real needs of local communities, take into account the task of preserving cultural memory, and ensure the formation of a sustainable and humane urban environment. This work has formed a system of spatial and social analysis, which includes: inventory of destruction; GIS analysis and work with open geospatial data; synthesis of historical, social, architectural and landscape contexts; principles of “slow rebuilding”, “care architecture”, inclusion and cultural memory. This methodology is suitable for application in other post-war cities of Ukraine.

Key-words: Post-war restoration; urban structures; architectural environment; planning solution; sustainable development

Rethinking Existing Bulgarian School Buildings in Large Cities: Two Case Studies Advocating the Critical Architectural Approach

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ABSTRACT

The majority of existing school buildings in Bulgaria are outdated physically, conceptually, and in terms of their ability to meet the evolving requirements of contemporary legislation, education, and society. Much of Bulgaria's public building stock and public space infrastructure is more than 60 years old and has undergone little to no maintenance over time, largely due to the country's political and economic transitions. Among the most pressing requirements currently facing existing schools is the transition to a single-shift, full-day study regime, mandated by the Ministry of Education in 2016, with a somewhat unrealistic deadline for completion by 2028. Because the largest student populations are concentrated in the central areas of major cities such as Sofia and Plovdiv—where population density is highest and vacant plots for new school buildings are scarcely available—the need for substantial expansion of existing school buildings is felt most acutely there. The urgency of responding to these changing requirements, combined with the specific Bulgarian legal framework governing school design regulations, which has been updated only sporadically since the 1960s, risks producing mechanical building expansions with insufficient consideration for the critical role of architecture. In the case of existing buildings intended for children, however, a comprehensive reconsideration of the built environment prior to physical intervention is of utmost importance. A growing body of research identifies space as a key factor in children's cognitive development. This article seeks to contribute to a shift in paradigm: away from hurried and superficial efficiency, and toward a critical and holistic architectural approach to the rethinking, renovation, and expansion of existing school buildings in dense urban areas. It does so by outlining a possible architectural approach through a careful analysis of two case studies: the 1950s-built 41st Primary School "St. Patriarh Evtimiy" in central Sofia, and the 1880s-built "St. Cyril and St. Methodius" High School of Humanities in central Plovdiv.

Key-words: Bulgarian school architecture; renovation; expansion; contemporary educational space; urban context; critical architectural approach

Theoretical and Practical Aspects of Club Building Modernization in Ukraine

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ABSTRACT

Contemporary transformational processes in Ukraine, associated with decentralization, changing sociocultural practices, and European integration, have intensified the need to modernize the network of club buildings as an essential component of public infrastructure. The traditional model of club institutions, established during the nineteenth and the second half of the twentieth century, has largely lost its relevance due to changing leisure patterns, the rapid development of digital technologies, evolving forms of social interaction, and increasing demands for the quality of public spaces. The destruction of numerous buildings and urban environments caused by Russian military aggression against Ukraine has made the reconstruction and renewal of damaged infrastructure an urgent task, not only for the post-war recovery period but also under current wartime conditions. In this context, the internationally recognized principle of Build Back Better has become particularly relevant, emphasizing the implementation of energy-efficient technologies, inclusive design solutions, and multifunctional protective facilities capable of meeting contemporary societal challenges. An analysis of the current condition of club institutions in Ukraine reveals a number of systemic problems, including physical deterioration of buildings, outdated spatial and functional layouts, limited adaptability, and insufficient integration into the urban environment. A significant proportion of these facilities fail to meet contemporary requirements for accessibility, energy efficiency, flexibility, and multifunctionality. The development and modernization of club buildings in historic cities possess specific characteristics determined by the constraints of the existing urban fabric and the necessity of preserving cultural heritage. Consequently, modernization strategies must balance the conservation of historical identity with the introduction of contemporary functions and architectural solutions. The modernization of club architecture in Ukraine is considered a multidimensional process encompassing organizational, methodological, functional-planning, and spatial dimensions. This study systematizes and generalizes contemporary approaches to club building modernization as an integrated process combining managerial, functional, and architectural-spatial components. The research identifies that the organizational and methodological framework of modernization is based on the implementation of multilevel governance systems, the development of partnership-based management models, and the application of comprehensive approaches to the assessment and transformation of existing facilities. Functional and planning modernization is characterized by the transition from narrowly specialized facilities to multifunctional and flexible spatial structures capable of accommodating diverse scenarios of use and responding to the evolving needs of local communities. Furthermore, the study demonstrates that volumetric and spatial transformations are aimed at creating an open architectural environment integrated into the surrounding urban context while meeting contemporary requirements for aesthetics,

sustainability, energy efficiency, and social interaction. Such transformations contribute to strengthening the role of club institutions as community-oriented cultural and social hubs. The practical significance of the research lies in the possibility of applying the obtained results to the development of reconstruction and modernization projects for club buildings, as well as to the formulation of strategies for the sustainable development of public and cultural infrastructure in Ukraine.

Key-words: Club buildings; modernization; adaptive reuse; cultural infrastructure; public architecture; multifunctional spaces; historic urban environment; community development

Additive Manufacturing with Earth-Based Materials: A Review of Existing Research and Further Needs for Study

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ABSTRACT

Environmental awareness and concerns about global warming have, now more than ever, prompted the research and development of innovative materials and technologies that embody values of environmental protection and sustainability for future generations. Additive manufacturing, among other advancements, has evolved in recent years with such speed that it now stands as a viable candidate for valuable, decentralized, low-consumption technology. Concurrently, materials with clay as a primary component are already used in their modern, technologized forms in contemporary built environments. Whether as rammed earth walls, hybrid structures, or merely as finishings, their ecological and hygrothermal qualities, among others, make them appealing. Additive manufacturing with earth-based materials has already been employed in construction and holds promise for future development and environmental metrics. Although it is currently experiencing a steep research and development trajectory, tangible results are somewhat delayed. This paper examines recent research on material characterization and additive manufacturing technologies in construction. It further explores the industry's missing features that currently hinder research and development, and supplements this overview with the findings of what the necessary directions for future studies should be. The conclusions of this critical review research paper shortlist future studies and experiments in the form of hypotheses to be tested, distinguishing between the immediate actions that could accelerate research in additive manufacturing for construction with earth-based materials, and the long-term, top-down, large-scale policies that would most beneficially impact its sustainability and growth as an independent industry.

Key-words: Earth-based materials; 3D printing; additive manufacturing; architecture; eco- efficiency

Genesis and Contemporary Trends in Olympic Infrastructure Development

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ABSTRACT

This study focuses on the Olympic Games and their evolution over time, particularly in relation to spatial development and land-use planning concepts, while taking into account the historical origins of this development. The study analyzes how the Olympic Games have gradually evolved from short-term sporting events into a comprehensive planning tool that supports the urban transformation of cities and entire regions. The aim of the research is to highlight key milestones in the history of the Olympic Games from the perspective of urban and infrastructure development, and to examine how spatial structures and planning concepts have evolved, particularly with regard to sustainability, cultural heritage, and polycentric organizational approaches. Examples from the 2024 Summer Olympic Games in Paris and the 2026 Milan–Cortina Winter Olmpic Games highlight the growing need for environmental responsibility and the need to reuse existing facilities, the revitalization of brownfields, and the integration of Olympic-related projects into the existing urban fabric. The spatial organization of the Games is undergoing a transformation, shifting from a single-hub model toward the creation of interconnected polycentric structures in line with the geographic and socio-economic characteristics of the host regions. The findings indicate a clear shift from short-term, partial solutions toward coordinated development projects that combine housing, transportation systems, and public spaces within the framework of long-term conceptual development strategies.

Key-words: Olympic games; legacy; polycentric models; adaptive reuse of existing infrastructure; multicenter model

Effects of Façade Geometry on Fire Spread

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ABSTRACT

The geometry of building façades has become an increasingly significant design parameter in contemporary architecture due to the widespread use of glass, steel, and lightweight cladding systems. While these façade solutions improve aesthetics and energy performance, they may also influence fire development and vertical flame spread, particularly in high-rise buildings. This study investigates the effects of façade geometry on fire spread by evaluating different façade configurations under identical fire conditions. A performance-based fire engineering approach is adopted to analyze how geometric characteristics such as recesses, projections, cavity formations, and façade continuity affect flame behavior, heat transfer, and smoke movement. Numerical simulations are carried out using Fire Dynamics Simulator (FDS), a computational fluid dynamics (CFD)-based software widely employed in fire safety engineering. Several façade geometry models are developed and subjected to the same fire scenario to enable a consistent comparison of fire propagation patterns. The simulation outputs, including temperature distribution, heat release behavior, and flame spread characteristics, are analyzed quantitatively using MATLAB. The results demonstrate that façade geometry has a substantial impact on fire spread mechanisms and may significantly alter the rate and direction of fire propagation. The findings highlight the necessity of considering façade geometry during the early stages of architectural design and emphasize the importance of integrating performance-based fire analysis with existing fire safety regulations. This approach contributes to the development of safer façade systems and supports informed design decisions for fire-resilient buildings.

Key-words: Façade geometry; Fire spread; Fire Dynamics Simulator (FDS); Performance-Based Fire Design

From Ornament to Design Logic: The Modernization of Ottoman Ornament in the Late Nineteenth Century

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ABSTRACT

This paper investigates the epistemological and spatial transformation of architectural ornament in the late Ottoman Empire through a critical reading of Raimondo Tommaso D'Aronco's architectural production in Istanbul. Moving beyond the conventional understanding of ornament as applied decoration, the study conceptualizes ornament as an operative mechanism that structures perception, encodes cultural meaning, and mediates ideological transitions within architecture. At the turn of the twentieth century, the Ottoman Empire was engaged in an intensified negotiation with modernity. This negotiation was not a linear process of Westernization but rather a complex reconfiguration of cultural identity through selective adaptation and reinterpretation. Within this context, D'Aronco's architectural language occupies a pivotal position. As an architect shaped by the intellectual climate of European Art Nouveau and the Vienna Secession, yet working within the symbolic and political framework of the Ottoman court, D'Aronco produced a hybrid architectural vocabulary that destabilizes rigid binaries between "East" and "West." Through detailed formal analysis of ornamental compositions, façade stratification, material articulation, and spatial sequencing, this research demonstrates that ornament in D'Aronco's works operates as a generative system rather than a supplementary layer. The ornamental surface becomes a site of negotiation where imperial representation, technological modernization, and aesthetic experimentation intersect. Instead of mimetically reproducing European stylistic trends, D'Aronco reinterprets Ottoman vegetal motifs, geometric rhythms, and calligraphic sensibilities within an emergent transnational modernist discourse. This process results in a re-coded ornamental language that simultaneously asserts continuity and articulates transformation. The study further situates D'Aronco's production within global networks of architectural circulation at the fin-de-siècle, highlighting the mobility of forms, ideas, and designers across imperial geographies. By tracing the dialogical relationship between Ottoman architectural heritage and contemporary European avant-garde movements, the paper challenges Eurocentric narratives that frame modernization as unilateral diffusion. Instead, it proposes a model of reciprocal exchange in which late Ottoman architecture actively contributes to the formation of modern architectural sensibilities. Methodologically, the research integrates architectural historiography, comparative visual analysis, and theoretical frameworks drawn from modernity studies and cultural hybridity. This interdisciplinary approach enables a reconsideration of ornament as both a spatial device and a political instrument. Ornament becomes a medium through which authority, reform, and identity are visually articulated, revealing architecture's capacity to embody ideological shifts. Ultimately, this paper argues that late Ottoman architectural modernity should be understood not as a peripheral imitation of European modernism but as a distinctive

and intellectually engaged response to global transformations. By foregrounding D'Aronco's works, the study reframes ornament as a critical agent in the production of architectural meaning and positions Ottoman architecture within broader transnational debates on modernity, representation, and cultural agency. In doing so, it contributes to the ongoing reassessment of architectural modernism as a plural and geographically entangled phenomenon rather than a singular Western trajectory.

Key-words: Ottoman architecture; ornament theory; modernity; cultural transfer, ViennasSecession; architectural Identity; Raimondo D'Aronco

Only Human - STEAM Education Between the Pandemic and the Artificial Intelligence Era

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ABSTRACT

STEAM education is an interdisciplinary approach that integrates science, technology, engineering, arts and mathematics in an integrative manner, in order to overcome the gaps between diffent disciplines and to develop long-life soft skills, like critical thinking, problem solving skills, creativity and autonomy. The concept of STEM education emerged at the beginning of the 21st century, but the letter A (for art) didn't come into play until 2020, marking a shift toward integrated approaches. Architecture is a discipline that, by definition, lends itself to experimentation and the study of STEAM, as it is a field that blends technical and artistic elements. In this regard, the programs developed by the De-a Arhitectura Association offer a broad field of study for a type of methodology that can also be applied in other areas. The association's educational programs were developed between 2011 and 2014, and approximately 35,000 children in Romania have already participated in them (more than 2,000 this year), making this a proven method. This article aims, on the one hand, to present the methodology developed as part of the educational program "Playing Architecture in My Town," designed for third- and fourth-grade children, and, on the other hand, to conduct a comparative analysis of the process carried out over two years with two cohorts of children: the COVID-19 pandemic generation (2019–2021) and the generation in which AI is gaining prominence (2024–2026). Both cohorts consisted of classes of 25 students aged 9–11, with the authors of the article serving as the classroom teacher and volunteer architect, respectively. Building on the analysis of the methodology presented in the first part, the second part focuses on adapting the proposed topics to the conditions of the pandemic and to the generation in which artificial intelligence is developing at an accelerated pace. The comparative analysis highlights the flexibility and adaptability of the method, presenting the changes introduced to adapt to different conditions and the teaching experiments conducted. The authors' considerations regarding the development of children's hard and soft skills are also presented. In conclusion, the STEAM approach is suitable for all age groups, and its tangible results are evident not only in terms of technical skills but especially in terms of social skills, namely emotional intelligence, creativity, problem-solving, communication and collaboration.

Key-words: STEAM; education; architecture; experiential learning; De-a Arhitectura Association

Bulgarian Exhibition Design since the 2010s from the Standpoint of Phenomenology in Architecture

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ABSTRACT

Exhibition design and spatial architecture are often at risk of becoming overly dependent on precedent, utilitarian logic, or image-making. Such dependence can result either in a failure to reflect the realities of contemporary human life or in an inability to acknowledge the complex historical and existential condition of the present-day individual. By examining the ways in which people dwell—both in the world at large and, more specifically, within the built environment—the philosophical tradition of phenomenology offers architecture an ethical and intellectual grounding. Rather than privileging formal precedent alone, it re-centres the human subject and affirms the inherently subjective, embodied, and evolving nature of experience. In the course of defining phenomenology, German philosophers Edmund Husserl and, above all, Martin Heidegger articulated fundamental dimensions of dwelling that address the human being in existential totality: as rational, historical, social, and emotional, and as continuously transformed through lived experience. It is therefore unsurprising that phenomenology has become a central point of reference in broader debates on inhabitation, spatial perception, and the making of architectural experience. The architecture and design of temporary public space often occupy a position in collective cultural memory that is far greater than their physical permanence might suggest, and at times even more significant than that of traditional, enduring works of architecture. Since the early 2010s in Bulgaria, a notable—though still young and fragile—shift has emerged in the understanding of how temporary cultural narratives, such as museum and gallery exhibitions, should be conceived. Exhibition design encompasses a range of skills drawn from architecture, interior design, graphic design, and scenography. Its purpose is to articulate a museum or gallery narrative through the creation of a coherent physical environment in which each object, photograph, document, and media element assumes a meaningful and logically structured place. The expressive means of exhibition design are virtually unlimited and continue to expand through the development of new technologies and evolving methods for the interpretation of cultural and historical heritage. In this sense, exhibition design stands in contrast to the conservative and often alienating display of artefacts in glass cases, accompanied only by labels and dense scholarly texts. Instead, it offers a wide spectrum of approaches attuned to contemporary culture, through which exhibition narratives may engage audiences more fully and leave a lasting impression. This article advances a phenomenological reading of recent exhibition design in Bulgaria, with the aim of revealing a systematic approach to the poetics of exhibition narrative and, through it, to the production of humane, vibrant, and sustainable exhibition environments.

Key-words: Exhibition design; space; museum; gallery; phenomenology in architecture

Post-Industrial Urban Environments and the Formation of Creative Personalities: Architectural and Social Dimensions

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ABSTRACT

The study examines the influence of post-industrial architectural environments on the formation of creative personalities and the emergence of countercultural artistic practices. The research focuses on the spatial and architectural characteristics of post-industrial cities that developed as a result of the decline of traditional industrial production during the second half of the twentieth century. Such urban environments are characterized by abandoned industrial facilities, fragmented urban structures, and the presence of large-scale industrial spaces that significantly transform the spatial and social organization of cities. The study explores the relationship between architectural environment, psychological perception of space, and the creative behaviour of individuals. Particular attention is given to the sensory and emotional influence of architectural space, including spatial scale, materiality, lighting conditions, and the organization of public environments. The research also examines how post-industrial urban landscapes create conditions for the formation of alternative creative communities and experimental artistic practices. The results demonstrate that post-industrial environments possess a paradoxical character. On the one hand, such environments are associated with economic decline, social marginalization, and spatial degradation. On the other hand, these same conditions create opportunities for the emergence of new cultural movements, countercultural practices, and experimental artistic expressions. Abandoned industrial spaces often become platforms for artistic experimentation due to their spatial flexibility, accessibility, and distinctive industrial aesthetics. The study concludes that the architectural characteristics of post-industrial environments play a significant role in shaping the psychological perception of space and influencing the development of creative communities. The transformation of industrial urban landscapes has contributed to the emergence of alternative cultural environments in which architecture becomes an important factor in the formation of new artistic practices and cultural identities.

Key-words: Post-industrial city; architectural environment; urban transformation; creative personality; counterculture; industrial heritage; urban space; cultural practices; environmental psychology; adaptive reuse.

From Segregated Institutions to Inclusive Spaces: A Comparison of Historical Evolution of Disability Law and Architecture in Romania and Sweden

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ABSTRACT

Throughout history, the treatment of persons with disabilities has been shaped by the interaction between legislation and political regimes that always changed societal perceptions upon them, which in turn have influenced the evolution of the built environment, form segregated institution to accessible and inclusive public spaces. The study compares two European trajectories: Romania, shaped by political discontinuities, institutional care, communism, post-communism reform and EU integration; and Sweden, marked by welfare state continuity, normalization policies, community-based services and independent living legislation. Through historical and legislative analysis, the paper investigates how legal frameworks shaped architectural responses for people with disabilities. The comparison also considers enforcement mechanisms, showing how Romania primarily regulates accessibility through technical norms and administrative sanctions, while Sweden combines building control with anti-discrimination legislation. The paper argues that legislation does not only reflect changing perceptions of disability, but also influences how inclusion materialized in architecture and public space.

Key-words: Inclusive design, architecture, disability history, disability legislation

When Accessibility Comes Before Beauty: Understanding Spatial Aesthetics Through Visual Impairment

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ABSTRACT

In architectural discourse, beauty is often discussed as an aesthetic quality, yet for people with visual impairments it may first depend on the possibility of understanding, accessing and safely experiencing space. This paper explores the relationship between accessibility and aesthetic experience in interior spaces for people with visual impairments. Starting from the premise that the perception of beauty cannot be fully activated when fundamental spatial needs remain unmet, the study proposes a theoretical parallel between Maslow's hierarchy of needs and the layered experience of architectural design. In this interpretation, accessibility represents the base level of spatial experience, followed by functionality, aesthetics and, ultimately, the poetic dimension of space. The research is based on semi-structured interviews conducted with ten visually impaired participants from Romania, focusing on their understanding of beauty in relation to interior environments. The responses reveal that, for many participants, the idea of a "beautiful" space is closely connected to orientation, safety, autonomy and usability. This suggests that aesthetic appreciation is often filtered through unresolved accessibility needs. The study argues that inclusive design should not treat accessibility as a technical addition, but as the foundation that allows higher forms of spatial experience to emerge.

Key-words: Inclusive design, autonomy, orientation, visual impairment,

GeoICT as a Catalyst for Sustainable Tourism Development and Heritage Interpretation in Post-Industrial Coastal Landscapes

Georgıa Cheırchanterı

Industrıal Desıgn and Productıon Engıneerıng Unıversıty of West Attıca

ABSTRACT

Post-industrial coastal landscapes often embody complex layers of historical memory, industrial transformation, and social change, presenting both challenges and opportunities for heritage-led development. In recent years, Geographic Information and Communication Technologies (GeoICT) have emerged as powerful tools for documenting, interpreting, and communicating cultural heritage through participatory and immersive digital environments. This paper explores the potential of GeoICT to function as a catalyst for sustainable tourism development and heritage interpretation in post-industrial coastal settings, using the case of Drapetsona–Keratsini, Greece. Located on the western waterfront of Piraeus, Drapetsona–Keratsini represents a culturally layered territory where traces of antiquity, refugee settlement, and industrial activity coexist within a dynamic urban landscape. Despite its historical significance and strategic geographical position between the port of Piraeus and the island of Salamis, the area remains largely under-recognized as a tourism destination. The coexistence of archaeological remains, industrial monuments, and intangible memories associated with refugee communities creates a unique cultural palimpsest with considerable potential for alternative forms of tourism based on learning, reflection, and community engagement. Drawing upon contemporary discussions on cultural resilience, heritage interpretation, and sustainable tourism, this study proposes a conceptual framework that integrates GeoICT applications—including multimedia Geographic Information Systems, web mapping environments, Esri ArcGIS StoryMaps, three-dimensional visualization, and digital storytelling—to support the reinterpretation of post-industrial heritage landscapes. Rather than presenting a completed implementation, the paper advances a transferable methodological approach through which spatial technologies can facilitate the co-creation of narratives, reveal hidden historical connections, and enhance the accessibility of cultural resources. The proposed framework follows a conceptual–logical–physical structure linking digital infrastructures, narrative mapping processes, heritage interpretation practices, and tourism outcomes. Through interactive spatial narratives, users are encouraged to navigate multiple temporal layers of place, connecting archaeological sites, industrial remains, oral testimonies, and collective memories into coherent interpretive experiences. In this context, GeoICT transforms maps from static representations into dynamic storytelling environments that foster emotional engagement, spatial understanding, and participatory knowledge production. Particular emphasis is placed on the contribution of GeoICT to sustainable tourism development. By promoting low-impact, experience-oriented forms of visitation, digital heritage environments can diversify local tourism offerings while reducing pressures associated with mass tourism. Virtual accessibility, immersive interpretation, and community participation support inclusive tourism models that strengthen local identity and encourage stewardship of cultural resources.

Consequently, tourism is reframed not merely as an economic activity but as a cultural process capable of enhancing social cohesion, educational value, and community resilience. The study argues that GeoICT-based heritage interpretation can contribute to adaptive urban regeneration by transforming overlooked post-industrial landscapes into meaningful cultural destinations. Beyond the case of Drapetsona–Keratsini, the proposed framework offers a scalable and transferable model applicable to other coastal regions characterized by layered heritage and socio-spatial complexity. By bridging geospatial technologies, digital storytelling, and sustainable tourism practices, GeoICT provides innovative pathways for preserving cultural identity, fostering community participation, and supporting resilient forms of local development in the face of ongoing environmental, economic, and social transformations.

Key-words: GeoICT; sustainable tourism development; heritage interpretation; narrative mapping; post-industrial landscapes; cultural resilience

Cultural Heritage Policies in Cape Verde

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ABSTRACT

The objective of this research is to characterize heritage infrastructures in Cape Verde, with a focus on the Plateau district, the historic centre of the capital city. These cultural heritage assets predominantly date from the Portuguese colonial period and are situated within the urban land-use areas designated by the Praia Municipal Master Plan, inside the city's urban perimeter. The study aims to assess and document the state of conservation of these infrastructures within the framework of existing spatial planning instruments. A detailed review of relevant bibliographic sources constitutes the primary analytical methodology for this case study. Additionally, the web platform of the Cape Verde National Heritage Institute provided critical data for the analysis. The results highlight the ongoing evolution of heritage protection policies, demonstrating trends toward more systematic documentation, improved monitoring, and enhanced transparency in decision-making processes. These findings reflect a gradual shift toward modernized, evidence-based heritage management. The study further identifies key challenges and proposes potential strategies to strengthen current policies, ensuring the effective safeguarding and sustainable enhancement of cultural heritage in Plateau.

Key-words: Cultural heritage, heritage conservation, Cape Verde, policy evolution

GIS and Cultural Heritage in Praia, Cape Verde

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ABSTRACT

The main objective of this research is to demonstrate how ICT tools using GIS can serve as a model for mapping and creating databases that describe heritage infrastructures. In Plateau, the centre of the capital city of Cape Verde Islands in Africa, the cultural heritage infrastructures were mapped and organized into a database, highlighting the role of GIS in spatial analysis and data management. The importance of ICT tools using GIS in cultural heritage was contextualized through geospatial data from Praia, emphasizing practical applications such as the development of specialized heritage inventories. The study also addressed the main challenges and potential solutions for effectively implementing GIS in the safeguarding and enhancement of cultural heritage in Plateau. Moreover, the integration of GIS enables a more dynamic understanding of spatial patterns, historical evolution, and vulnerability factors affecting heritage assets. By supporting multi-layered analysis, GIS facilitates informed decision-making, assists in monitoring urban transformations, and promotes more efficient preservation policies. This approach reinforces the value of geospatial technologies as essential tools for sustainable heritage management.

Key-words: Geographic Information System, mapping Praia infrastructures, cultural heritage, Cape Verde

Understanding the Place: Ensuring Social Acceptance Through Perceived Continuity in Architectural Intervention

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ABSTRACT

Restoration in architecture operates increasingly at the crossroads between material conservation, functional adaptation, and community expectations. This study advances the concept of "perceived continuity" as an operational tool for ensuring social acceptance in architectural intervention. Rather than evaluating restoration solely through material authenticity or stylistic accuracy adapted to the place, the paper proposes that one way to ensure long-term legitimacy of any architectural intervention depends mostly on how the community where it is placed perceives it. Therefore, only the architectural standpoint is not enough for a successful intervention as the integration with the people that use and/or promote the final result in critical for its success. In this regard, based on how effectively it preserves the cognitive, spatial, and most importantly the symbolic identity of a place while accommodating contemporary needs, the intervention is sure to be a success or doomed to be a failure. The research intends to develop a practice-oriented intervention framework grounded in three measurable dimensions: spatial legibility, material dialogue, and narrative integration. The framework is tested through comparative analysis of four restored heritage buildings in Brăila, Romania: "Maria Filotti" theater, "Embiricos" house, "Carol" restaurant, and "Buna Vestire". Greek church. Each case represents a distinct typology — cultural, former residential, hospitality, and religious—each subjected to varying degrees of functional adaptation and technical intervention, all embedded differently in the social mindset. By using on-site observation, archival comparison in the interventions for each one and post-intervention perception analysis, the research evaluated how specific technical strategies contributed or challenged public acceptance in the search for perceived continuity. Such strategies involved façade conservation or adaptation, reversible structural consolidation in a historical protected landscape, contemporary necessary material insertion, and function reconfiguration. The research findings indicate that interventions preserving recognizable spatial hierarchies and symbolic architectural elements achieved higher levels of social legitimacy, even where internal functions or construction systems were substantially modernized or changed whatsoever. The results suggest that perceived continuity functions as a true mediating crucible for the conservation integrity, adaptive reuse and social acceptance. Another conclusion is that by translating socio-cultural values into technical design parameters, architects can ensure both heritage sustainability and community endorsement for the intervention, to some extent. The paper concludes with a replicable methodological matrix of questions necessary to guide future restoration projects seeking to reconcile authenticity, adaptation, with public trust within evolving urban contexts.

Key-words: Place memory; social acceptance; perceived continuity; architecture

Learning About Wooden Heritage: Summer School in The Village Museum

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ABSTRACT

The aim of this study is to analyze the impact of alternative methods of learning about wooden heritage for architecture students and pupils in the summer school that took place in the Banat Village Museum in Timisoara. For the mandatory summer school practice in 2024, the students from first, second and third years of study from the Faculty of Architecture and City Planning in Timisoara were organized in teams with secondary school students that enrolled in the summer school activities. Both students and pupils visit the building site of Povergina wooden church and traditional wooden houses from the village museum. The architecture students were guided by professors for the building site visit and hands on activities with pupils. Specialists were invited to make presentations on site about landscape and heritage, regional designations for the traditional houses constructive elements, traditional plaster, different types of wood and wood finishes. The students guided pupils in filling observation forms about natural setting and wooden traditional buildings in the village museum, measuring, drawing and modeling the houses that they studied. Pupils presented the houses models at the end of activities. We analyze feedback from students and pupils given in written anonymous questionnaires at the end of the summer school. Both students and pupils were delighted to work hands-on for the models, learn more about wooden heritage in a different setting than formal learning, linking theoretical knowledge from different disciplines with practical skills. Children were delighted to work and to make friends with architecture students. In addition, students practiced social skills working with pupils, like working in team and communicating with children. In conclusion, the learning process involved emotional connections, brought knowledge about heritage, developed skills for observation, measuring, drawing and modelling, and built correct attitudes towards the values of built heritage.

Key-words: Heritage education; students and pupils; summer school; village museum; wooden heritage

Cultural Heritage and Contexts Today: Three Concepts, Two Places, One Challenge

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ABSTRACT

Today, cultural heritage once again takes its rightful place in everyday life beyond and despite the laws. The paper explores the evolving relationship between cultural heritage and contemporary urban contexts, focusing on the tension between dynamic living heritage and static legislative frameworks. It aims to start a debate to foster bridging the gap between emerging theories on different scales and their practical application in diverse environments thus suggesting a direct contribution to the contemporary debate in the field of architectural heritage and conservation of historical structures. The research presents three key concepts – the Historic Urban Landscape (HUL), New Contextualism, and the Narrative Theory of Conservation. It demonstrates that these frameworks share a common foundation in value-led assessment, shifting the focus from protecting physical structures to managing change and significance. Through comparative case studies of the Ancient Quarter in Hanoi, Vietnam, and the Chengene Skele Fisherman Village in Bulgaria, the study identifies a recurring legislative friction. In both cases, vibrant, community-driven urban fabrics (characterized by socio-functional ingenuity and living narratives) face potential stagnation due to rigid legal protections that prioritise visual compatibility and historical freezing over social continuity. The paper concludes that for cultural heritage to remain a relevant and active participant in contemporary life, conservation must be redefined as the management of change rather than the preservation of the status quo. It argues for a conjunction of heart and head, calling upon legislative bodies and institutions to adopt more flexible, inclusive, and resilient codes of conduct. Such frameworks should recognise the interdependence of tangible and intangible values and respect local communities as the primary narrators of their heritage. Ultimately, the research highlights that while laws are necessary to protect values, they must not sever the emotional and functional ties that keep heritage alive.

Key-words: Cultural heritage; historic towns; historic urban landscape; contextualism; theories in cultural heritage conservation; narrative theory; management of change; Hanoi – Vietnam; Chengene Skele – Bulgaria

Shipping Container Housing in Construction: BIM and Prefabrication MEP Systems for Affordable Housing Solutions

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ABSTRACT

This study explores how Building Information Modeling (BIM) and prefabricated mechanical, electrical, and plumbing (MEP) systems can help make shipping container housing an efficient and affordable option. The study asks how BIM-coordinated prefabricated MEP can improve the time, cost, and quality performance of container-based projects, since very few existing studies focus on this exact combination. Using a qualitative comparative review, the paper examines published case studies and articles that describe BIM coordination and prefabrication processes, and report results such as schedule changes, labor hours, costs, rework, waste, and safety. The findings show that when BIM and off-site prefabrication are used together, projects often finish faster, with reported schedule cuts of 50 to 60 percent, lower on-site labor needs, and capital cost savings, even though design and coordination can take longer at the start. Prefabricated MEP modules and racks built from coordinated models also reduce clashes, rework, and waste, improve first-time fit, and provide safer and more controlled working conditions. For shipping container housing, these benefits are especially important because containers have tight clearances and little room for error, so standard MEP pods and panelized walls planned in BIM can drop into place quickly and accurately. The paper concludes that BIM-coordinated prefabricated MEP systems can lower per-unit costs and speed up delivery for container housing, while also noting limits such as code approvals, transport constraints, factory setup costs, and the need for better cost data and clearer standards.

Key-words: BIM; prefabricated MEP; shipping container housing; affordable construction; modular design

Energy Piles as an Element of Sustainable Urban Energy Systems

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ABSTRACT

Urban areas are facing increasing challenges related to energy efficiency, decarbonization, and sustainable infrastructure development. Among the innovative technologies supporting the transition toward low-carbon cities, energy piles have emerged as a promising solution that combines structural and energy-related functions. Energy piles are foundation elements equipped with heat exchange systems that enable the extraction and storage of shallow geothermal energy while simultaneously serving as load-bearing structures. This paper examines the potential application of energy piles in sustainable urban energy management. The study discusses the technical principles of energy pile systems, their integration with ground-source heat pumps, and their role in reducing the energy demand and carbon footprint of buildings. Particular attention is given to the opportunities for implementing this technology in residential, commercial, and public infrastructure projects within densely populated urban environments. The environmental and economic benefits of energy piles are evaluated, including reductions in greenhouse gas emissions, improved energy efficiency, and the optimization of land use through multifunctional infrastructure. The paper also identifies key challenges associated with the deployment of energy piles, such as geological constraints, design complexity, and investment costs. The findings indicate that energy piles can contribute to sustainable urban development by providing a reliable renewable energy source without requiring additional surface space. Their integration into modern construction projects offers a viable pathway toward more resilient and energy-efficient cities.

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Key-words: Energy piles; shallow geothermal energy; sustainable cities; urban energy management; renewable energy; ground-source heat pumps; energy efficiency

Interior Design as a Determinant of Indoor Air Quality in Children's Spaces: Sources of Volatile Organic Compounds (VOC), Eco-Standards, and Mitigation Strategies

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ABSTRACT

People spend more than 90% of their time indoors, so interior design has a direct influence on the quality of air that children breathe. This paper reviews volatile organic compounds (VOCs) in children's spaces as an indoor air quality issue with implications for health. Children are a vulnerable group due to their rapid physiological development, narrower airways, and higher respiration rates per kilogram of body weight compared to adults. Chronic exposure to VOCs within children environments is linked to respiratory disorders, allergic reactions, and neurological delays. The purpose of the study is to identify the main indoor sources of VOCs in children's environments, summarize associated health risks, and propose practical strategies for reducing exposure. The research identifies that the main VOC sources in children's interiors are furniture, composite wood products, adhesives, coatings, flooring materials, and renovation-related finishes. Emissions are typically highest during and shortly after installation, painting, or renovation, and they are influenced by ventilation, temperature, humidity, product formulation, and heating conditions. Evidence from schools and kindergartens in Bulgaria shows elevated indoor VOC levels, with higher concentrations in winter and after renovation activities, especially where PVC window frames, laminate, latex paint, and linoleum are present. Lower-emission options include water-based varnishes and UV-curable lacquers, solvent-free powder coatings, low-VOC water-based paints, and mineral paints. For flooring, carpets and vinyl generally show higher emissions, while wood floors with water-based finishes can perform better, depending on the specific product and treatment. Finally, the analysis reveals that soft furnishings utilizing flexible polyurethane foams and consumer decor items like aroma diffusers introduce continuous, high-volume indoor VOC loads. To help with the search of low VOC furniture and materials, standards, certification, testing and labels exist like Indoor Air Comfort (IAC) and EU Ecolabel, but there is no one unified low VOC label. Interior design could contribute to poor indoor air quality and is directly correlated to children's health. Therefore it will require a fundamental shift in interior architecture from reactive air purification to proactive source control. Professionals should swap high-emission composite woods, synthetic carpets, and polyurethane-based varnishes in favor of low-emission materials verified by standardized testing, labels and certification. Furthermore, because peak chemical diffusion occurs immediately during and after application, designers should insist on proper ventilation during and post installation.

Key-words: Volatile organic compounds (VOC); indoor air quality; children's rooms; low-emission materials; interior design; low VOC design

Multi-Objective Performance Analysis of Façade-Integrated Photovoltaic Shading Devices in İzmir Climate

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ABSTRACT

Photovoltaic shading devices are important design features that can achieve both solar control and energy generation on building facades. These devices should be evaluated not only in terms of energy generation but also considering the building's total energy consumption and lighting demand. Especially in the early design phase, comparing different photovoltaic shading configurations with multiple performance targets contributes to a more balanced and performance-oriented facade design. This study aims to evaluate the energy generation, total energy consumption, and lighting performance of facade-integrated photovoltaic shading devices in the climate of Izmir. The study considered three different photovoltaic shading concepts, three window width ratios, and eight orientation parameters; a total of 1,392 scenarios were created based on 174 parametric facade geometries. The scenarios were analyzed using the DesignBuilder simulation tool, and annual performance outputs were evaluated comparatively. The study method is based on Pareto-front analysis, which aims to identify non-dominated alternatives within simulated scenarios. Accordingly, energy generation is considered a target to be maximized, while total energy consumption and lighting consumption are considered targets to be minimized. Relationships between performance indicators were interpreted through parallel coordinate plots; scenario distribution of Pareto-front alternatives was analyzed in terms of orientation, window width ratio, and PV shading configuration. The findings indicate that, under the İzmir climate, no single photovoltaic shading parameter provides direct superiority across all performance objectives; however, certain combinations of orientation, opening width ratio, and PV geometry achieve a more balanced performance. Pareto-front alternatives reveal significant relationships between energy generation, total energy consumption, and lighting energy. This result suggests that photovoltaic shading devices should be evaluated not only in terms of maximum energy generation, but also in relation to the building's energy demand and daylight-dependent lighting requirements. Overall, the study demonstrates that Pareto-based approaches provide a useful conceptual framework for identifying balanced façade scenarios when evaluating façade-integrated photovoltaic shading devices through multi-objective performance analysis during the early design phase.

Key-words: PV shading device; multi objective performance; building energy simulation; façade design; pareto-front analysis

Informal Public Spaces and The Degree of Their Plasticity

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ABSTRACT

Post-socialist cities, and therefore also those in Slovakia, are fundamentally marked by the functionalist principle of planning. Their urban structure is therefore characterized by a large proportion of open and poorly defined space. Contemporary urban development is often implemented without the necessary concept on an "ad hoc" development approach, which generates "residual open spaces". The aim of this paper is to point out the hidden and unused potential of the aforementioned "open" city spaces through innovative approaches to their valorization. The authors perceive the aforementioned residual spaces as host areas that can be integrated into the functioning urban fabric through initiatives and implemented interventions based on participation with their future users. The paper focuses on defining and categorizing open, or residual, city spaces depending on their location, character and significance; on the possibilities of their bottom-up transformation and new use, on innovative methods of involving differentiated actors in their transformation and the degree of their malleability. The paper presents the results of participation and possible transformation of selected open city spaces, which were implemented at the Faculty of Architecture and Design of the Slovak University of Technology in Bratislava, in cooperation with local governments and users. It is a presentation of several years of mapping possible interventions in public spaces.

Key-words: Public space; urban interventions; public activities; activation of public space; initiation of public space

The Factor of Globalization Versus the Identity of Urban Structures

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ABSTRACT

The paper presents research focused on the transformation of urban structures, which has been carried out within the Glocal vertical studio for the past three years at the Faculty of Architecture and Design of the Slovak University of Technology in the form of research-by-design. The research analyses the application of characteristic elements of urban structures that are based on the specificities of the location and can significantly strengthen the identity of the place and the city. The focus of the research is based on the increasing pressure of globalization and the mechanical transfer of construction schemes and patterns to the local environment, without taking into account the context. The adoption of patterns from different cultures has accompanied humanity since the beginning. The degree of influence depended on the reach of a particular culture or power relations/ties. With increasing mobility and the overall interconnectedness of the world, the process of pattern transfer has intensified and has largely freed itself from adapting to local conditions. The research is focused on verifying the application of current global trends in the development and transformation of urban structures in the local context on model solutions. It emphasizes the application of sustainability principles (environmental, economic, social) in strengthening the identity and authenticity of the formed environment. The research also evaluates the degree of application of characteristic building elements of the urban structure (architectural, urban and natural) based on the character of the place and compares their application in implemented model solutions with commercial projects in a given area. The work is based on the method of comparative research of model solutions and real projects through the evaluation of the degree of application of characteristic building elements reflecting local specifics and at the same time using current trends in sustainable development. The aim of the research is to point out the necessity of strengthening the genius loci in applying current and progressive global trends.

Key-words: Sustainable urban design; residual space; research-by-design; globalization, genius loci

Asymmetric Co-Evolution of EVCS Infrastructure and Urban Spatial Structure within Diurnal Rhythms

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ABSTRACT

The alignment between electric vehicle charging station (EVCS) infrastructure and urban spatial structure is fundamental to sustainable city planning. However, this potential is restricted by conventional design, which oftentreats EVCS layout as a passive adaptation to urban structurerather than a co-evolving process. To quantify this interaction, a cross-lagged panel model is applied to analyze a comparative dataset of Chengdu and Chongqing from 2020 to 2025. A dynamic urban composite index is devisedin this paper by fusing hourly population mobility data with the static urban spatial structure. The findings reveal an asymmetric relationship: the city's stable underlying structure (in particular, road networks) predicts the long-term EVCS layout (0.21–0.28). In contrast, the charging infrastructure reveals a targeted association with specific urban functional structures (UFS), representing a distinct alignment with the nighttime residential function (0.11).These findings provide quantitative evidence to revisit the passive response paradigm, implying an integrated framework that coordinates the macro-level structural basis with micro-level functional rhythms.

Key-words: EV Charging Station (EVCS); asymmetric co-evolution; dynamic urban spatial structure; Cross-Lagged Panel Model (CLPM); wavelet fusion

Sustainable Urban Development in Denmark: Integration of Environmental Standards into the Architectural Design System

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ABSTRACT

The purpose of this study is to investigate the integration of environmental standards into the architectural design and urban planning system of Denmark as a key component of sustainable urban development. The research examines the regulatory framework, environmental requirements, and architectural strategies that ensure the environmental performance, energy efficiency, and climate resilience of the built environment. Particular attention is given to the role of building regulations, Life Cycle Assessment (LCA), CO_2 emission reduction measures, and energy efficiency requirements as essential mechanisms influencing architectural and urban design decisions. The results indicate that Denmark has developed a comprehensive and effective system for integrating environmental standards into architectural practice through the implementation of regulatory instruments, environmental assessment tools, and climate-oriented state policies. Environmental standards significantly influence architectural solutions, including spatial organization, selection of construction systems and materials, and the formation of sustainable urban structures. Key principles identified in the Danish model include compact urban development, integration of sustainable transport infrastructure, use of environmentally responsible materials, optimization of natural lighting, implementation of green infrastructure, and climate-adaptive design. It is concluded that the Danish approach represents an effective model for achieving sustainable urban development through the systematic integration of environmental standards at all stages of the building life cycle. The findings demonstrate the potential applicability of this experience to improve architectural design practice and regulatory systems in Ukraine, particularly in the context of post-war reconstruction, in order to ensure the development of environmentally sustainable, energy-efficient, and resilient urban environments.

Key-words: Sustainable urban development; environmental standards; architectural design; urban planning; sustainable architecture; energy efficiency; life cycle assessment; Denmark; environmental regulation; built environment

The Role of Chief Architects in Post Mining Landscape Rehabilitation

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ABSTRACT

Rehabilitation of post-mining landscapes represents one of the most complex and controversial environmental and social challenges of the 21st century, requiring the integration of industrial heritage, ecological regeneration, and local community identity. This review synthesises international literature addressing post-mining land use, reclamation, and heritage-based landscape management from an interdisciplinary perspective. Drawing on more than twenty selected international studies, the analysis identifies six major research domains: (a) ecological restoration and natural succession, (b) the heritage interpretation of industrial landscapes, (c) post-mining land use and sustainability, (d) social impacts and landscape identity, (e) technological and methodological innovations, and (f) ethical and interdisciplinary integration. The findings reveal that post-extractive landscapes are not merely environmental problems but potential arenas for cultural renewal and socio-economic transformation. Addressing this problem requires responsible decision-making, which can lead us to involvement of local chief architects. The study delegates its results to the jurisdiction of chief architects, while presenting their actual network in Hungary and future possibilities of the Hungarian Chief Architects' Network in the field of landscape and urban rehabilitation.

Key-words: Reclamation; industrial landscape; heritage conservation; landscape identity; post-mining land use; sustainability; chief architect' network

Adaptive Reuse as Design Pedagogy: Student-Led Re-purposing of Al-Qasimiyah School and Building B at AURAK, Ras Al Khaimah

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ABSTRACT

In rapidly developing contexts such as the UAE, many buildings from earlier development phases are increasingly perceived as outdated and, therefore, expendable. Yet these structures often carry significant value—not only because of heritage or memory, but also due to their location, proven functionality, and the resources embedded in their construction. This paper presents adaptive reuse as both a sustainability strategy and a teaching framework, demonstrating how senior architecture students at the American University of Ras Al Khaimah (AURAK) investigated and proposed new futures for two existing buildings in Ras Al Khaimah. The paper is designed as a visually driven contribution, supported by drawings, diagrams, and comparative "before/after" design narratives. The study argues that repurposing existing buildings can outperform demolition-and-rebuild approaches by reducing construction waste, limiting landfill burdens, and conserving material and energy resources already invested in the building fabric. In this sense, adaptive reuse functions as architectural "recycling," where design decisions are informed by what can be retained, upgraded, and re-activated. Within studio pedagogy, this approach shifts student learning away from purely hypothetical design and toward evidence-based, context-responsive practice, requiring engagement with real constraints—structure, envelope, services, circulation, and user needs—while also addressing environmental performance and community value. The two student projects form the core of the study. The first one focuses on the adaptive reuse of Al-Qasimiyah School, a typology widely constructed in the UAE during the 1970s and 1980s using precast concrete technology to deliver standardized quality and rapid construction in response to expanding educational demand. Through analysis of its spatial logic, structural system, and urban position, students identified the building's latent capacity for transformation and proposed new programs that retain its core fabric while improving environmental performance and contemporary usability. The project demonstrates how "ordinary" modern-era buildings can acquire renewed civic relevance when their typological and construction significance is recognized as an asset rather than a limitation. The second project examines Building B on the AURAK campus, a prefabricated courtyard building constructed over 35 years ago and used across multiple institutional phases, including hosting AURAK's early operations (under the premises of George Mason University and the Higher Colleges of Technology). Although the building once supported the full academic life of the university, it is currently relegated to storage for the facilities department. Students documented the building's adaptability, evaluated its current underutilization, and developed reuse proposals that re-position it as an active contributor to campus life, demonstrating how existing prefabricated structures can be reprogrammed through targeted architectural interventions rather than replacement. By centering on these two student-led investigations, the paper highlights adaptive reuse as a pragmatic pathway for sustainability and a powerful vehicle for architectural education where learning occurs through direct engagement with real buildings, their constraints, and their potential for new life.

Key-words: Adaptive reuse; re-purposing; sustainability; embodied resources; precast concrete; prefabrication; design pedagogy; Ras Al Khaimah; UAE

Issues of Urban Overdevelopment in Post-Socialist Bulgaria

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ABSTRACT

Urban overdevelopment has become one of the most controversial issues of contemporary urban development in Bulgaria and other post-socialist countries. While extensive research has been devoted to urban sprawl and low-density expansion in Western Europe and North America, significantly less attention has been paid to the phenomenon of high-intensity overdevelopment within already urbanised areas. This paper examines the specific characteristics of urban overdevelopment in post-socialist Bulgaria and explores its relationship with development rights, urban justice, and the efficiency of urban planning. The paper argues that the key difference between urban sprawl and high-intensity overdevelopment lies not only in their spatial form but also in the institutional mechanisms that generate them. Both processes stem from an increasing demand for housing and tourist accommodation, driven by urban population growth, rising living standards, and the expansion of tourism and recreation. However, while urban sprawl has been widely recognised as unsustainable and has been extensively studied, the causes and consequences of high-intensity overdevelopment remain insufficiently researched. The central thesis of the paper is that the mechanism of urban development in Bulgaria encourages excessive development intensity because it distorts the allocation of development rights. As a result, the benefits generated by intensive development are largely captured by private landowners, whereas many of the associated environmental, social, and infrastructural costs are transferred to local communities. Drawing upon the Theory of Complex Property Rights, the paper treats development rights as a valuable resource whose allocation plays a crucial role in shaping urban development outcomes. As development rights are created through municipal planning and supported by public investments in infrastructure and urban services, the study finds that local communities have a legitimate claim to the value generated by these rights. From this perspective, overdevelopment can be interpreted as a consequence of the improper initial allocation of development rights and the resulting imbalance between public and private interests. Finally, the paper discusses policy implications and proposes the application of value capture instruments based on the “user pays” or “beneficiary pays” principle. Particular attention is given to betterment levies, transferable development rights, and charges on development rights as potential tools for promoting more sustainable and equitable urban development.

Key-words: Urban overdevelopment; development rights; property rights; value capture; urban justice; post-socialist cities

Urban Regeneration as a Strategic Pact: From Technical-Operational Tool to Metropolitan Vision. Lessons for Bucharest and Chișinău — Eastern European Capitals with Post-Soviet Heritage

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ABSTRACT

In post-Soviet Eastern European capitals, urban regeneration faces a structural paradox: the very planning instruments designed to guide transformation — the General Urban Plans (GUPs) — are systematically undermined by their own implementation mechanisms. This paper examines urban regeneration not merely as a technical procedure, but as a strategic pact, through a comparative analysis of Bucharest and Chișinău — two capitals sharing a Soviet planning heritage yet following divergent trajectories within the European integration framework. Drawing on the authors' extensive primary research — including a doctoral thesis on strategies for urban regeneration in distressed and obsolete industrial areas of Bucharest, another on polycentric territorial development in Romania, and direct involvement in the revision process of Chișinău's General Urban Plan — this paper documents a recurring pattern: site-specific planning instruments (Zonal Urban Plans — ZUPs) have routinely converted strategic mixed-use and revitalization zones into high-density residential developments. This conversion erodes the balanced functional structure envisioned by master plans and generates cumulative infrastructure deficits. The paper advances a three-axis framework for effective urban regeneration: (1) the planning document as a social-political pact requiring long-term commitment, rather than a purely technical-normative instrument; (2) a metropolitan governance model — inspired by the Budapest Model of post-communist strategic planning reform and the London metropolitan experience — that combines adaptive planning cycles with a 25-year strategic vision; and (3) polycentric development as a structural corrective to Soviet-era monocentrism, closely integrated with sustainable mobility. The conclusions argue that making Eastern European cities safer and more sustainable calls for a paradigm shift: from traditional blueprint planning toward strategic adaptive governance, in which the urban regeneration of deindustrialized zones becomes the primary instrument of spatial rebalancing — rather than continued peripheral expansion.

Key-words: Urban regeneration; post-Soviet cities; General Urban Plan; strategic planning; adaptive governance; polycentric development; metropolitan governance; Bucharest; Chișinău

The Right to the City as a Normative Framework for Inclusive Urban Planning

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ABSTRACT

This article conceptualizes the "right to the city" as a normative framework applicable to urban planning and governance, bridging critical urban theory and European human rights standards. The study aims to operationalize inclusiveness as a legally relevant and practically applicable criterion for assessing administrative decisions in spatial planning, construction regulation, and urban development. The research combines conceptual analysis of the "right to the city," doctrinal examination of Ukrainian urban-planning and architectural legislation, and synthesis of relevant European Court of Human Rights jurisprudence. Particular attention is given to regulatory instruments governing accessibility standards, building norms, and procedural safeguards in urban decision-making. The findings demonstrate that urban inclusiveness functions not merely as a technical requirement of barrier-free design but as a substantive and procedural standard of good governance. Access to information, meaningful participation, reasonable accommodation, proportionality, and regulatory compliance emerge as key elements shaping the legitimacy of planning and construction decisions. The study shows that accessibility standards embedded in building regulations operate as instruments for fulfilling broader public law obligations and ensuring sustainable and equitable urban development. The "right to the city" may serve as an evaluative framework linking urban development objectives with human rights-based governance standards. In this perspective, urban space is understood as a legally and socially constructed environment where inclusiveness becomes a measurable and reviewable planning criterion. The proposed approach contributes to interdisciplinary dialogue between law, urban planning, and architecture, offering a structured model for assessing inclusivity within contemporary urban governance systems.

Key-words: Right to the city; inclusive urban development; urban governance; spatial planning; accessibility standards; human rights in urban space; public law framework; sustainable cities

The Right to the City in Public Law: Participation, Urban Governance, and Judicial Practice in Ukraine

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ABSTRACT

The purpose of this study is to analyse public participation in urban decision-making as a public-law mechanism for the realisation of the right to the city in Ukraine. The research examines the theoretical foundations of the right to the city, its conceptual ambiguity and multidimensional nature, as well as the legal framework governing citizen participation in urban planning processes. Particular attention is given to the regulatory mechanisms of public consultations, public hearings, and participation in the development of urban planning documentation, as well as to the role of judicial practice in shaping standards for the implementation of participatory procedures. The results indicate that public participation in Ukraine has been institutionalised through a system of formal procedural requirements; however, its practical implementation reveals significant tensions between formal compliance and substantive effectiveness. Judicial practice demonstrates the emergence of differentiated approaches to assessing the legality of urban decisions, including: (1) disputes related to the absence or improper conduct of public consultations; (2) disputes concerning the forms and methods of participation; and (3) disputes focused on the materiality of procedural violations. The findings show that courts increasingly apply a substantive test, evaluating whether procedural deficiencies could have affected the outcome of decision-making. It is concluded that public participation constitutes a central element of the public-law mechanism of the right to the city, functioning not merely as a procedural formality but as a criterion of legitimacy of urban governance. At the same time, the effectiveness of its realisation depends on overcoming the formalistic approach to participatory procedures and ensuring their genuine impact on urban decision-making processes. The study highlights the need for further development of legal standards that would strengthen the substantive dimension of participation and align Ukrainian practice with contemporary theoretical approaches to the right to the city.

Key-words: Right to the city; public participation; urban governance; public law; urban planning; public consultations; judicial practice; administrative disputes; local self-government; Ukraine

Operational and Regulatory Frameworks for UAV Deployment in Post-Earthquake Response

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ABSTRACT

The rapid deployment of Unmanned Aerial Systems/Vehicles (UAS/UAV) has transformed modern post-earthquake emergency response, offering critical real-time situational awareness and automated structural damage assessment. Their operational efficiency heavily relies on complex risk-based aviation regulations, strict data governance, and harmonized cross-agency workflows. This study explores multi-level operational protocols and regulatory frameworks (International, European, and National) to identify institutional and technical integration gaps in disaster management, with a specific emphasis on underdeveloped national frameworks such as Bulgaria's. A comparative analysis was conducted across international disaster guidelines (INSARAG, ICAO), European binding frameworks (EASA, GDPR, AI Act, INSPIRE Directive), and the Bulgarian Disaster Protection Act. Operational maturity, automated deployment strategies, and technical requirements for transforming raw UAV imagery into legally admissible evidentiary data were cross-compared using selected case countries. The study establishes a centralized "UAV–DBL (Digital Building Logbook)–Decision-Making Loop" that effectively bridges field-acquired georeferenced data with structured digital building repositories to ensure legal data traceability. Countries such as Japan, Italy, and Türkiye exhibit highly integrated workflows linked to early seismic warning systems, whereas Bulgaria’s framework remains fragmented due to a lack of flexible procedures for emergency airspace corridors, certified operator registries, and standardized metadata validation. To improve national disaster resilience, UAS/UAV operations must move beyond ad hoc deployments and be permanently embedded within unified civil protection frameworks. Future deployments are expected to prioritize harmonizing data standards across interoperable geographic information systems (GIS), enabling real-time AI-driven damage analysis and alignment with the structural digital twins of affected settlements and critical infrastructure.

Key-words: Unmanned Aerial System/Unmanned Aerial Vehicle (UAS/UAV); Post-Earthquake Emergency Response; EASA Regulatory Framework; Digital Building Logbook (DBL); Legal Admissibility of Geospatial Data; Disaster Risk Governance

Random-Search Selection of Cost-Optimal Energy-Efficiency Measure Packages for an Educational Building Stock Based on Energy-Audit Results

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ABSTRACT

Buildings account for a large share of global final energy consumption and carbon emissions, and deep retrofit of the existing stock is widely recognized as one of the most cost-effective decarbonization levers. The starting point for any retrofit decision is an energy audit, which quantifies a building's baseline performance and produces a list of technically feasible energy-efficiency measures (EEMs). Each measure has a capital cost, an achievable annual energy saving, and a service life. The decision that follows is hard to solve: which subset of measures should be implemented, and at what intensity, so that the building reaches a required energy-efficiency class at the lowest possible cost. This problem is discrete-continuous, multi-parameter, and multi-extremal. The number of candidate packages grows combinatorially with the number of measures; the savings of individual measures interact and saturate rather than add linearly, so that the marginal value of each measure depends on the others already chosen; and continuous design parameters such as insulation thickness, equipment capacity, and on-site renewable share must be tuned jointly with the binary decision of whether each measure is included at all. The European Energy Performance of Buildings Directive frames precisely this task as the identification of cost-optimal packages of measures, and a substantial body of work has applied metaheuristics - predominantly genetic algorithms and their multi-objective variants - to it. Such population-based methods are powerful but relatively heavy: they require population management, careful operator design for mixed integer-continuous variables, and large evaluation budgets, and benchmark studies repeatedly find that no single algorithm dominates across all building-energy optimization problems. This paper proposes and demonstrates a lighter-weight alternative. It adapts a self-learning integer random-search method, originally developed and validated by the author for a structurally analogous class of problems - the optimal placement, sizing, and service-zone definition of urban facility networks such as multistorey garages, filling stations, and outpatient-clinic networks - to the selection of cost-optimal EEM packages driven directly by energy-audit results. The decision vector combines binary measure-selection variables with continuous intensity parameters. A penalty-function criterion minimizes the annualized cost, defined as annualized capital expenditure net of annual energy-cost savings, subject to four families of constraints: attainment of the required energy class (the total package saving must not fall below the audit-derived target), a capital budget ceiling, technical bounds on every continuous parameter, and measure-compatibility conditions expressed through a logical matrix that captures mutual exclusion and precedence between measures. Because individual savings interact, the package saving is modeled with a smooth saturation toward a physical ceiling to avoid double counting, with each measure contributing a diminishing-returns saving curve. The solver follows the two-tier structure of the author's random-search apparatus. In the inner loop, a self-learning local

search explores the continuous parameters of the active measures: from the current point a random step is taken simultaneously along all coordinates, with normally distributed increments; the common search scale is increased after successful steps and reduced after failures, taking large strides far from the optimum and fine steps near it, with reflection rules returning the point to the feasible region when bounds are violated. Heterogeneous physical parameters are first mapped to a dimensionless space by a linear transformation, equalizing their influence on the objective. In the outer loop, the discrete package composition is varied by integer random search, flipping selection variables subject to compatibility, while a Monte-Carlo global search generates uniformly distributed initial packages and expanding forbidden zones progressively exclude unpromising regions. This synthesis locates the global cost minimum without exhaustive enumeration. The method is demonstrated on the 2018 energy audit of the Turin Polytechnic University campus in Tashkent (TTPU): eleven buildings with a combined conditioned floor area of 23,282 square meters and a baseline Energy Use Intensity of 183.3 kWh/m2/yr, corresponding to class D. The study target is class B. Eight candidate measures derived from the audit are considered, spanning envelope upgrades (wall and roof insulation, glazing replacement, air sealing), high-efficiency systems (LED lighting with controls, HVAC retrofit, building automation), and rooftop photovoltaic generation. Across several hundred Monte-Carlo restarts with adaptive local refinement, the optimizer converges to a cost-optimal feasible package of seven measures that reduces the Energy Use Intensity from 183.3 to 118 kWh/m2/yr - a 35.6 percent reduction that moves the stock from class D to class B. The required capital cost is about USD 1.96 million, within the assumed USD 2.2 million budget, with an annual energy-cost saving on the order of USD 129,000 and a simple payback of about 15.2 years. For comparison, a naive strategy of selecting all measures at maximum intensity reaches a marginally lower Energy Use Intensity but at roughly 1.26 times the cost and well over budget, confirming that the random search achieves the class target far more economically by tuning intensities and omitting low-value measures. The results show that a self-learning random search is an effective, transparent, and computationally light optimizer for audit-driven EEM package selection, converging in a few dozen restarts without the machinery of population-based algorithms. Beyond the specific case, the work demonstrates the transfer of an optimization apparatus validated on urban facility-network placement to a building-energy problem of the same mathematical type, contributing to a unified random-search framework across urban-planning and building-engineering applications. The approach is particularly suited to public-sector retrofit programs in developing-economy contexts such as Central Asia. Planned extensions include coupling the optimizer to a dynamic building-energy simulation engine and a multi-objective formulation returning a cost-saving-comfort Pareto front.

Key-words: Energy efficiency; building retrofit; energy audit; random search method; cost-optimality; energy-efficiency measures; Energy Use Intensity; multi-extremal optimization; Uzbekistan.

Evaluation of High School Building Rehabilitation: Case Study Itabuna/BA

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ABSTRACT

The need of school places in Brazil has led to a practice of converting commercial buildings, such as warehouses, shops, and car dealerships, into schools without adequate technical adaptations. In this context, sustainability is often narrowly defined as installing active technologies, such as photovoltaic panels (the conversion of sunlight into electricity) and rainwater reuse systems, while fundamental structural deficiencies, including insufficient cross-ventilation (natural airflow through spaces) and inadequate natural lighting, remain as a problem. This article examines the limitations of this solution through a case study of a high school in Itabuna, southern Bahia, which exemplifies the improvised adaptation of a commercial building for educational use. The facility analyzed has 1,560 m² and functions in a former car dealership. The evaluation employed a School Building Assessment Model for Environmentally Sustainable Rehabilitation, structured around five axes, such as safety, accessibility, environmental comfort, pedagogical suitability, and resource efficiency. This model, implemented as a structured technical tool, aligns the building's physical condition with NBR 15575 and NBR 9050 standards (Brazilian National Standards for Performance and Accessibility, respectively). Application of the model revealed significant disparities. For instance, the infrastructure achieved 92% (excellent), while habitability (60%) and safety (67%) were rated as "good." Sustainability indicators for location (93%) and energy efficiency (80%) demonstrated high performance; however, natural lighting (29%), green roof (20% - a roof covered with vegetation), and environmental education (20%) were identified as critical deficiencies. The photovoltaic system kept the energy consumption below 100 kWh/month, and rainwater harvesting reduced water use to 58 m³, significantly below the average for comparable schools. However, the original architectural design places the windows concentrated on a single facade, resulting in one-sided ventilation (airflow entering only from one side), CO_2 buildup, and a reliance on artificial lighting. These issues are classified as Priority 1 (urgent intervention) and directly affect students' mental and cognitive performance. The results indicate that the energy generated by solar panels is mainly consumed by the air conditioning systems installed to compensate for the lack of natural ventilation, creating a cycle of inefficiency that the model was able to identify. Sustainable rehabilitation should consider that, before adopting active technologies, interventions should prioritize changes to the building's structure, such as placing openings in opposite walls, using perforated elements (building components that allow air to pass through) oriented according to prevailing winds, and solar control (measures to manage heat and light from sun exposure) on the most exposed facades. The assessment model shows that it is not feasible to call a building sustainable simply by adopting some active solutions without considering passive solutions that ensure user well-being in the pursuit of green certifications.

Key-words: Sustainable rehabilitation; school environment; environmental comfort; building performance; technical evaluation

The Risks of Using Mining Tailings Effluent in Agriculture in Peru

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ABSTRACT

Mining is essential to the global economy, but it generates large quantities of tailings (mining waste), which represent one of the greatest environmental and social challenges. Water from mining tailings, primarily used in agriculture, is gaining increasing interest, especially in arid regions. These tailings can provide certain nutrients and improve soil fertility under controlled conditions; however, their application carries significant risks due to the presence of heavy metals and adverse physicochemical conditions. Currently, research is focused on how to mitigate these risks and harness the potential benefits. Improper use can increase the concentration of heavy metals (Cu, Pb, Cd, Zn, As, and others) in soils and crops, posing risks to human health. Worldwide, mining activities have caused contamination of agricultural soil with toxic metals, raising concerns about environmental risk and human health. In addition, a potential source of heavy metal contamination has been identified in agriculture in Peru through the use of irrigation water originating from the water in these tailings dams.

Key-words: Water effluents; mining; agriculture irrigation; heavy metal risk

Chemical, Structural, and Morphological Impacts on Halloysite Nanotubes Extracted from Algerian Black Manganiferous Kaolin by Acid Reductive Leaching Using Hydrogen Peroxide

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ABSTRACT

Halloysite nanotubes (HNTs) are minerals consisting of hydrated aluminosilicates (Al2Si2O5(OH)4.nH2O) that belong to the clay group. They are becoming increasingly popular in nanoscience and nanotechnology due to their tubular morphology. Algerian halloysite clay, known as DD Kaolin, mainly consists of HNTs, but it also contains manganese minerals (about 8%) that give it a black color. To recover and bleach the HNTs, a solubilization of manganese minerals is carried out with an acid reductive leaching using hydrogen peroxide, which makes them soluble as Mn(II), then they are washed away. The optimized treatment with a minimum of reagents (H2O2, HCl) ensures extraction of more than 95%wt. of Mn, and produces a perfectly white HNTs with a Si/Al=1.11 ratio, very close to that of halloysite 7Å (1.04). XRD analysis shows that the crystal structure of HNTs is not impacted but confirms the elimination of manganese minerals. FTIR analysis does not show any changes in the HNTs bonds. Simultaneous thermal analysis shows an enrichment in HNTs. Adsorption and desorption nitrogen analysis reveals that the BET surface area (60cm2/gr) and pore volume (0.16cm3/g) increase slightly compared to untreated kaolin values (48cm2/gr, 0.11cm3/g), whereas the radius of the nanotubes increases significantly in the mesoporous range from 15 to 20nm. The SEM analysis shows halloysite nanotubes very little impacted by the chemical treatment, with dimensions of ~1000nm in length and ~50nm in diameter. The increase in reagents and processing conditions does not completely eliminate manganese but increases the Si/Al ratio and degrades the structure and bonds of the HNTs, which leads to its collapse. This study shows that the recovery and bleached of HNTs from black kaolin DD without significant damage is perfectly feasible using the minimum reagents (HCl, H2O2) for extraction only manganese and other undesirable elements.

Key-words: Halloysite nanotubes; leaching; HCl; H2O2; bleaching; characterization

Bioclimatic Architecture and Water-Inspired Design, Crișuri Water Basin Administration Building, Romania

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ABSTRACT

The wave equation inspired the vertical sunshades of a representative bioclimatic building. This building is the headquarters of the Romanian Waters, Crișuri Water Basin Administration, located on the Peța River in Oradea, Bihor County, Romania. The plan features an internal courtyard that reinforces the place's identity. The concept of the building is simple: water that develops vegetation. The wave equation that inspired the vertical sunshades also recalls the green-blue infrastructure managed by the same administration. Vegetation develops from "water." Ivy, used as a green sunshade, shades two glazed facades. The roof was initially designed as a green terrace, preserving the potential for this on later implementation of the originally conceived biophilic design. Other bioclimatic elements include the inner courtyard and the southern facade, horizontally shaded by the terrace console, and the aesthetic vertical Corian sunshades, which optimally shade the western facade. Building on this biophilic design, architecture near a river can effectively establish a representative, iconic point for the blue-green infrastructure. This could enable future water access points or the integration of water-hydrogen energy into the built environment as part of a holistic approach.

Key-words: Bioclimatic architecture; biophilic design; water-inspired design; headquarters building of the Romanian Waters; Crișuri Water Basin Administration

Integrating Placemaking into Urban Regeneration: Approaches and Options for Institutionalization

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ABSTRACT

In times of polycrisis, the limited municipal budgets and the increasing demands of citizens and residents for the quality of public spaces are among the main challenges facing the sustainable management of public spaces in urban areas in Europe. Citizen empowerment and their inclusion in the process of public space renewal and decision-making develop responsibility, empathy and a sense of belonging – behavioral elements necessary for building a sustainable urban environment and communities. Placemaking has the potential to act as a catalyst for systemic change, enabling transition toward more resilient, democratic, and people-centered urban development models. The paper examines the integration of the placemaking approach into urban governance, regeneration, and development, with a focus on European practices and case studies. The primary objective is to analyse how placemaking can be systematically embedded within municipal structures to foster more inclusive, sustainable, and community-oriented urban environments. The research draws on findings from the "Cities in Placemaking" programme and detailed case studies from Germany, Italy, The Netherlands, Spain, Belgium, and Bulgaria. To ensure a structured and comparative assessment, the case studies are analyzed and evaluated against a set of spatial, urban governance that enable the identification of both enabling conditions and systemic barriers to the institutionalization of placemaking practices. The socio-spatial criteria are the location, morphology, the environmental settings of the sites and it uses, and the social, environmental, and spatial impacts achieved after during and after the placemaking. The governance set of criteria comprise the degree and continuity of citizen participation and co-creation, the level of institutional integration within municipal governance structures, the extent of cross-sectoral and interdisciplinary collaboration; the adaptability of the approach to existing governance practices; degree of programming provided by different local plans, and the availability of sustainable funding mechanisms framed by long-term implementation strategies. The results indicate that while European cities are at varying stages of adopting placemaking, common patterns emerge. Placemaking is increasingly recognized as a flexible and holistic tool capable of addressing complex urban challenges such as social inequality, climate adaptation, mobility, and public space regeneration. However, significant barriers persist, including bureaucratic structures, insufficient cross-departmental coordination, limited long-term community engagement, and difficulties in measuring impact and securing funding. The comparative case study demonstrates that successful implementation relies on strong citizen participation, interdisciplinary collaboration, and adaptive governance models that balance top-down planning with bottom-up initiatives. The study concludes that integrating placemaking into urban governance requires structural and cultural transformation within municipal administrations. Key recommendations include the development of dedicated placemaking capacities,

improved stakeholder engagement mechanisms, innovative funding strategies, and the promotion of knowledge exchange between cities. Finally, the study suggests concrete strategies for institutionalizing placemaking and further highlights the importance of decentralized governance mechanisms and the establishment of intermediary structures between municipal administrations and civic actors as key instruments for the sustainable integration of placemaking into existing urban governance structures and practices.

Key-words: Placemaking; urban regeneration; urban governance; European cities; participatory and inclusive planning

NBS Practices in Urban Areas: Towards a Holistic Approach to Knowledge Valorization

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ABSTRACT

Implementation of nature-based solutions (NBS) has emerged as urgent agenda and priority within international interdisciplinary research in response to urban challenges as climate change, biodiversity lost, and social inequalities. Since the early 2010s NBS have been subjected to conceptualization from isolated green interventions to recognizing their multifunctionality and the necessity of integrating diverse stakeholder knowledge through co-creation and adaptive governance. However, controversies persist regarding the balance between top-down institutional frameworks and bottom-up community-led initiatives, within the debates on the optimal pathways for fostering inclusive, legitimate, and sustainable NBS governance. Failure to address these gaps leads to underestimation of scalability and sustainability of NBS interventions, and hence - to limiting their transformative potential for urban regeneration and climate adaptation. The aim of the research is to provide a comprehensive framework for knowledge valorization of NBS practices in urban settings. A systematic evaluation of 42 Projects from the CORDIS (1) database was performed against the seven groups of knowledge valorization principles, recommended by the Council of the European Union (2). As a result, a holistic framework for knowledge valorization of NBS practices is proposed, that respects the NBS type and its context, as well as the NBS co-creation in the course of its lifecycle. Recommendationc are formulated on the effectiveness of the knowledge valorization mechanisms and their combination with different pathways for knowledge sharing and learning within the governance network and providing multiple benefits at various spatial scales.

Key-words: NBS; knowledge valorization; urban governance; EU funded research projects

An Integrated Approach to Landslide Monitoring for Enhancing the Safety of Urbanized Areas

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ABSTRACT

This study presents an integrated geodetic approach for landslide monitoring based on the combined use Interferometric Synthetic Aperture Radar (InSAR), Global Navigation Satellite Systems (GNSS), and Terrestrial Laser Scanning (TLS). The need for such an approach arises from the significant risk that landslides pose to communities, infrastructure, and urban areas. The proposed methodology combines the complementary strengths of the three techniques to detect, monitor, and analyze ground deformations across different spatial and temporal scales. InSAR provides regional information on surface displacements, GNSS ensures high-precision control and validation of the observed deformations, while TLS complements the analysis with detailed three-dimensional information on terrain changes. The integrated approach highlights the potential of combining InSAR, GNSS, and TLS to improve the reliability of landslide monitoring and support engineering decision-making for effective risk assessment and management in urban environments.

Key-words: Integrated geodetic approach; landslide monitoring; Interferometric Synthetic Aperture Radar (InSAR); Global Navigation Satellite Systems (GNSS); Terrestrial Laser Scanning (TLS)

Enhancing Blast Fragmentation Uniformity via Stemming Length and Explosive Charge Distribution: Case Study at Chouf Amar Quarry, Algeria

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ABSTRACT

Stemming length and the distribution of the explosive charge along the blasthole are two of the main controls on blast fragmentation uniformity in open-pit quarries. This study uses the Kuz-Ram fragmentation model, implemented in the SHOTPlus software, to assess how these two parameters govern the particle size distribution produced by blasting at the Chouf Amar quarry (M'sila, NE of Algeria). The company's current blast design, based on a continuous explosive column with a stemming length representing 38% of the hole depth, was found through Kuz-Ram prediction to yield a low uniformity index (n = 1.08) and about 27% of oversized blocks (>1000 mm), reflecting weak, under-confined fragmentation in the upper part of the bench. An alternative blast design using a discontinuous (intermediate) charging technique, distributing the explosive energy more evenly along the blasthole, was then proposed and modelled with the same approach; it raised the predicted uniformity index and reduced the proportion of oversized blocks to about 10%. These results show that stemming length and charge continuity are first-order controls on fragmentation uniformity, and that Kuz-Ram-based prediction can be used a priori, before field implementation, to select a blast-design geometry that meets a target fragmentation requirement; the resulting gains in loading productivity follow directly from this improved uniformity.

Key-words: Blasting; fragmentation uniformity; stemming length; SHOTPlus; Kuz-Ram; oversize blocks

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